

WEIR (R. F.) & SEGUIN (E. C.)

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*Contribution to the
Diagnosis and Surgical Treatment of
Tumors of the Cerebrum.*

BY

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FROM

THE AMERICAN JOURNAL OF THE MEDICAL SCIENCES,

JULY, AUGUST, AND SEPTEMBER, 1888:

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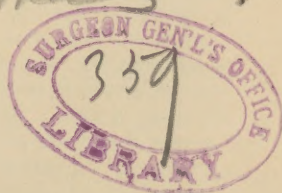
SURGEON TO THE NEW YORK HOSPITAL; PROFESSOR OF CLINICAL SURGERY IN THE COLLEGE OF PHYSICIANS
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presented by the author



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DIAGNOSIS AND SURGICAL TREATMENT OF TUMORS OF THE CEREBRUM.

THE case which forms the basis of this contribution to a novel field of surgical progress, presents many points of interest in relation to diagnosis, and illustrates the possibility of the removal of a deeply placed tumor, and the prolongation of life through operation. The medical and surgical remarks upon the subject which the case illustrates are separately made by the authors.

HISTORY OF THE CASE. [BY DR. SEGUIN.]

Mr. B., æt. thirty-nine, married, German, brewer, residing in Bridgeport, Conn.; attending physician Dr. Charles C. Godfrey.¹ Was first seen during my absence by Dr. J. Arthur Booth on August 12, 1887. The following is a transcript of the notes then taken:

Is a strong-looking German. Has been married ten years; has four healthy children. Wife has had no miscarriages. There is no history of gonorrhœa, or chancre, or of any syphilitic symptom. Has been in the habit of drinking beer, but no strong drink. Has smoked moderately. Is right-handed. No epileptic attacks in childhood. Was perfectly healthy until the autumn of 1882. He then had malarial fever, apparently of mixed remittent and intermittent forms. During this illness he had a good deal of pain in the head, and one day, feeling strangely, he got up to go to the window, when his wife observed a spasm of the right cheek and neck (head and face turned to the right). This was a twitching spasm, and did not involve the arm; consciousness was not lost. A similar attack occurred a year later, and during the third year he had an occasional attack in the night. She is positive that until 1885 there were no spasmodic movements in the hand or arm. He was otherwise well, with the exception of an occasional headache, until two years ago, when one day he fell unconscious and bit his tongue. He has had similar attacks at long intervals since; they lasted only a few seconds and left him very weak. These epileptic attacks were preceded by an aura consisting of a "frightened feeling," followed by twitching or jerking in the right hand and arm and in the right side of the face, followed by loss of consciousness.

The attacks have occurred at all hours, and no exciting cause has been observed. Has taken bromide of potassium lately, and has had

¹ The authors of this paper desire to express their obligation to Dr. Godfrey for his hearty coöperation in the management of this case, and for his skilful treatment of it during the long period in which it was under his individual care.

fewer attacks. Memory not as good as formerly, and speech has become "thick" (bromide effect?). General health has remained good.

Examination.—Stands well with eyes closed. No tremor of tongue or fingers. Tongue deviates slightly to the right. Vision is good; never diplopia. The right hand is weak; dynamometer showing R. 30° and 32°; L. 35° and 32°. No ataxia. Patellar reflex normal. (State of facial muscles not noted.)

Treatment.—To stop beer entirely; to take twenty grains of bromide of sodium morning and noon, and forty grains at bedtime.

August 26. Dr. Seguin's notes. Patient now states that the first epileptiform attack was five years ago. A long interval followed, as above noted. Again denies, in most positive terms, the occurrence of chancre or any syphilitic symptom. No injury to head. Attacks always begin in the right facial muscles; speech is almost wholly suspended, even when consciousness is fully preserved. Can call out "water" or "ice," but cannot talk. He has had no motor attacks in the hand alone. Patient is not aware of weakness of the right hand and arm, but admits that he is awkward with this member, and that his handwriting has become bad. In the last eight or nine months the right upper extremity has felt heavy or "numb." Speech is said to have been thick and slow for over two years. Memory much impaired.

Examination.—Pupils equal, of medium size and active; muscles all act well (no prism-test). The optic nerves and retinal vessels appear perfectly normal. The lower facial muscles on the right side are distinctly paretic, and there is slight deviation of the tongue to the right. Can close left eye alone, but not right; frontalis normal. The right arm is paretic; grasp, R. 32° and 30°; L. 33° and 35°. Stands equally well on either foot; the walk is normal. Patellar reflex slightly greater on the right side. Sensibility is unimpaired, except a very slight diminution of tactile sensibility, as tested by æsthesiometer, on the right cheek. Mental action slow but accurate.

Recent attacks: about June 10th or 12th, August 11th, 16th, and 18th. Intermittent fever has reappeared; a chill followed by high fever on August 21st, 23d, and 25th.

Symptomatic diagnosis.—Right-sided Jacksonian epilepsy, with facio-brachial paresis.

Anatomical diagnosis.—Tumor of the left motor zone in the facial centre.

Treatment.—Ordered a mixture containing to each dose, Fowler's solution, 5 minims; bromide of potassium, 20 grains; iodide of potassium, 15 grains; fluid ext. of rhamnus frang., 3ss, on rising, after midday meal, and at bedtime. For tertian fever, to take sulphate of quinine 20 grains to-night, and 10 grains every night afterward.

September 21. Comes with Dr. Godfrey. Has had only one severe epileptic attack since last call, viz., on August 31st. On September 17th, had a slight localized attack in the right cheek. Speech is worse; slow and somewhat interrupted, though not, strictly speaking, syllabic. The patient himself has noticed the aggravation, and adds that he can't always think of the right word to speak. On September 13th, had a chill followed by fever. During this attack he had severe pain in the left side of the head. No constant headache; no vertigo. Complains of a constant feeling of numbness, or a numb-weight in the whole of right upper

extremity, but not in cheek, tongue, chest, or leg. Has been somewhat drowsy in daytime.

Examination.—Pupils and optic nerves are normal, right facial muscles as before. Tongue tremulous, but nearly straight. Paresis of right arm more pronounced: grasp, R. 36° , 37° , 37° ; L. 40° , 37° , 39° . Stands less well on right foot (eyes closed). Patellar reflex is greater on right side.

Sensibility. No anæsthesia of face. On pulps of left fingers the points of the æsthesiometer are distinguished at from 2 to 3 mm., on the right at from 3 to 5 mm. This slight tactile anæsthesia is most marked on thumb and index. Feels texture of cloth as well with right as with left fingers. The muscular sense, as tested by passive movements and weights, when eyes are closed, is normal.

The desirability and feasibility of an operation in the near future, if symptoms increase, are discussed with Dr. Godfrey. I feel reasonably certain that the lesion is a tumor affecting the motor apparatus of the left hemisphere, in the parts associated with the face and hand. Whether the tumor is cortical or subcortical is open to doubt. The local twitching, or clonic spasm being in favor of a cortical lesion, while the absence of (constant) headache would strongly point to a medullary lesion.

October 19. Has had several seizures. One (on September 23d), beginning as usual in the right face, became a complete epileptic attack with biting of the tongue. States that frequently after attacks the right cheek is flushed and hotter than the left. Has had more severe and more constant pain in the left parietal region. The hemi-paresis is worse; saliva flows almost constantly from angle of mouth; the right cheek and buccal muscles are almost powerless; the tongue deviates very slightly to right (not at all in proportion to the facial paralysis); the anæsthesia, though very slight, is demonstrable on right face and hand; to coarse tests the muscular sense is normal in upper extremity. Percussion develops tenderness over an oval area $2\frac{1}{2} \times 2$ inches above the left ear, and overlying the motor zone. I advise an operation, exploratory at least, as soon as the patient can be induced to submit to it.

November 15. Mr. B. comes to New York expressly to have the operation performed. Since last date, a thorough trial of iodide of potassium, to 200 grains three times a day (four days at that dose), has been made, without good or bad effects. The bromide has been continued at an average dose of sixty grains *per diem*, but several partial attacks have occurred.

A careful physical examination reveals substantially the same symptoms, viz., paralysis of right lower facial muscles, paresis of right arm (grasp: R. 23° ; L. 40°); leg apparently normal; constant drooling from right side of mouth; slight aphasic and agraphic faults. Anæsthesia as before, tactile, and very slight; muscular sense preserved. No symptoms in optic apparatus. The greatest tenderness to percussion, coinciding with seat of greatest constant pain, is in a spot just in front of the auriculo-bregmatic line, and from 8 to 10 centimetres (3 to 4 inches) above the external auditory meatus.¹ The patient was

¹ This area of tenderness was marked at the time upon a cranial diagram, and subsequent comparison of this sketch with that represented by Fig. 1, and with the estimated actual location of the tumor at the time of operation, showed exact coincidence.

sent to Dr. R. F. Weir to be examined by him with a view to operation, and was admitted the same day to the New York Hospital as a private patient in his service.

On the same day careful measurements of the cranial temperature were made upon the shaven scalp. The instruments used were four of a set of Seguin's surface thermometers, self-registering, made expressly for me by Casella, of London, in 1883. These thermometers were not graduated until four months after making, and Mr. Casella guaranteed their accuracy. Just before using them to-day, I tested the entire set of twenty instruments, comparatively, in water at about the normal temperature of the body, and found that most of them agreed to $\frac{1}{10}^{\circ}$ C., and the others (with one exception) within $\frac{1}{2}^{\circ}$ C. Four of the most accurate were used upon the patient; each instrument being held firmly upon the scalp (with enough force to leave an indentation) for five minutes. The results were recorded by an assistant, while Dr. Gordon, the House Surgeon, and myself managed the instruments. The following is the tabulated result in Fahrenheit degrees.

	Right side.	Left side.
Frontal regions	93.2°	94.3°
Temporal regions	98.0°	96.0°
Vertex one inch from median line	96.8°	95.0°
Occipital region	94.1°	97.2°
Over supposed site of tumor	96.3°	97.7°

Nov. 17. The measurements were taken again in the same manner. Temperature of room 78.5°. Axillary temperature of patient 97.7° (hospital thermometer).

	Right side.	Left side.
Frontal regions	95.0°	96.4°
Temporal regions	97.2°	96.8°
Vertex one inch from median line	96.4°	96.4°
Occipital region	96.4°	97.2°
Just above edge of ears	97.7°	98.0°
Half way up Rolandic line	96.8°	96.4°
Over supposed seat of tumor	96.1+°	96.1°

The averages of these measurements for the two sides of the cranium were:

	Right.	Left.
First series	95.7°	96.0°
Second series	96.5°	96.75°
	<u>96.1°</u>	<u>96.37°</u>

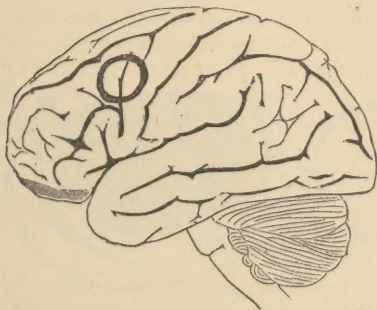
The temperature over the supposed seat of the tumor was 1.4° higher on the left side the first day, but on the second day no differences of any moment were noted.

For the whole head these averages were almost in accord with those of Maragliano and Seppilli (96.98°), and higher than those of Gray (95.5°). As the averages of Gray represent more nearly the normal in our climate and in our inhabitants, we must conclude that in the case of Mr. B. there was a general elevation of cranial temperature amounting to about 0.7°.

These thermometrical results appear specifically worthless; yet the absence of positive elevation of temperature over the supposed site of the tumor might be added to other indications to be referred to later, and which led us to be prepared for a subcortical lesion.

Final diagnosis.—It is almost certain that Mr. B. has a cerebral tumor involving the centre for the face and partly that for the arm in the left hemisphere. On account of the late appearance of headache, and the absence of marked elevation of temperature over the seat of the tumor, we must not be unprepared to find a subcortical tumor. Nature of tumor uncertain, probably a sarcoma. The appended figure is a reduction of an Ecker diagram with the probable site of the tumor marked by a heavy ring, drawn before the operation, which was done

FIG. 1.



Outline diagram of left hemisphere. The dark ring represents the site of the tumor, estimated before the operation.

by Dr. Weir on November 17th. The tumor was found, deep under the surface of the brain, in the indicated location. Although, surgically speaking, it was a subcortical tumor, yet it probably invaded the cortical gray matter deep in the sulcus between the gyri (*vide* Figs. 3 and 4).

THE OPERATION. [BY DR. WEIR.]

The operation was performed with the assistance of Drs. Seguin and Bull, under ether and with antiseptic precautions, spray included, Nov. 17, 1887. The patient's head, shaved the previous day, had been for twenty-four hours covered with gauze moistened with 1 to 60 carbolic acid, after a thorough scouring with whale-oil soap and water. The auriculo-bregmatic line was marked out by Dr. Seguin on the scalp, and at a point a little in front of this line and just anterior to the lower half of the fissure of Rolando a minute perforation was made through the scalp and through this a mark made with a sharp pencil to indicate on the skull, when exposed, the place to be centred by the trephine. An oval flap of the scalp, three inches broad and including the periosteum, was then raised from the skull in such a way that its base was toward the frontal region. This was held back by a suture at its apex to the eyebrow, and the many arterial and venous bleeding points secured by clamps. The first button of bone with a one inch trephine was removed about one and a half inches above and a little in front of the left ear. A second button of a similar size was taken away just in

front of this and a little above it. The intervening portions of bone were rapidly gnawed away with a double gouge forceps, and the cranial opening enlarged on all sides in the same way until it reached an area of three by two inches.

The dura mater bulged only slightly but pulsated freely, and presented a normal appearance. It was opened by lifting a part with a tenaculum and by first penetrating it with a knife, and then cutting it with curved blunt scissors a quarter of an inch from the skull edge for about three-quarters of the circumference of the hole, leaving the attached part uppermost. This flap was then reflected (Fig. 2). One of

FIG. 2.

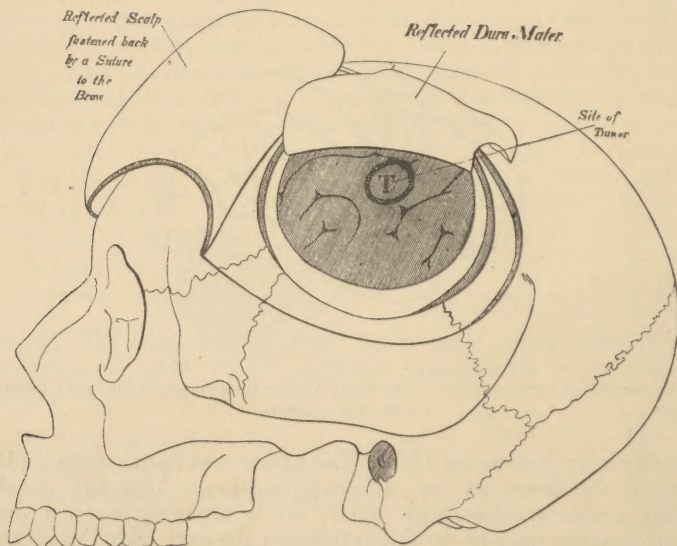


Diagram showing lines of incision and location of tumor.

the vessels of the pia was wounded in the procedure and was ligated after some little difficulty. The middle meningeal vessels crossing over the dura were secured, partly before the incision in this membrane, by a curved needle carrying catgut through the dura, an expedient taught me by my venerated preceptor Dr. Gurdon Buck, or by tying the vessels as they were cut. Two branches at the lower part of the wound were, however, only controlled by small sponges at first, and subsequently by iodoform gauze pressed between the dura and the skull.

As the brain itself was exposed it was noticed to bulge decidedly into the opening, but its pulsations were manifest. Nothing abnormal was seen on the exposed surface, though by some it was supposed the convolution situated most posteriorly was violet in color. This was thought, however, by me, to be due to the recent extravasation (alluded to above) from the damaged pia vessel. The finger recognized no tumor or abnormality. Quite firm but gradual pressure, sufficient to permit the finger to be carried below the skull level and slightly beyond the area of the bone opening, furthermore revealed nothing. It began to appear

as if the growth was beyond the reach of surgical art, when firm pressure posteriorly encountered a deep resistance of a hard mass of small size underneath the previously suspected convolution. The convolution was gently parted with the finger-nail and a director, and at a depth of nearly an inch, directly inward and in probable close proximity to the upper part of the ventricle a mass was exposed to the touch, and subsequently indefinitely to sight by means of gently used retractors, made of bent spoon handles. It was then ascertained to be a growth nearly the size of a large almond, or, more correctly, in shape and size as large as the end of the forefinger, not encapsulated and seemingly infiltrated into the brain tissue. It was, after a brief trial to remove it with a director, lifted out readily with a Volkmann's spoon one-half inch in diameter, which had been previously blunted for the purpose.

After the tumor had been taken away a separate hard piece the size of a pea was recognized and also removed. The finger could now be passed to the depth of fully an inch and a half, and it gave me the impression of being in a smooth cavity. No hemorrhage from the brain itself occurred. The normal condition of the brain having been corroborated by Dr. Seguin's digital examination, a rubber drainage tube was carried to the bottom of the cavity and out through the posterior margin of the wound. The dura mater was stitched together except over a small area where the tube emerged, and after a final washing of the wound with a 1 : 5000 sublimate solution had been done.

FIG. 3.



FIG. 4.



Fig. 3.—Outline diagram of left hemisphere, with ring showing topography of tumor.

Fig. 4.—Diagram of oblique transection passing through tumor (Pitres's coupe frontale), showing the actual location of the tumor as determined by the operation.

The disks of bone and a number of the bone fragments which had been chipped off by the rongeur were replaced over the sewn dura. These disks and pieces of bone had been kept in a towel wet with 1 to 60 carbolic acid, and kept at a suitable temperature by immersing the jar containing them in warm water for over an hour. Two strands of horse-hair and one of catgut were placed under the replaced scalp for drainage, and a fresh piece of iodoform gauze tucked between the skull and dura mater at its lower part where the meningeal oozing was still troublesome, and after suturing the scalp with catgut, a sublimate dressing dusted

with iodoform, was applied with moderate pressure. At the termination of the operation pulse 125. General condition good.

The tumor lay entirely within the white substance and was situated, in the judgment of Dr. Seguin, at a depth of three-quarters to one inch below the posterior edge of the second frontal and the anterior edge of the precentral gyri; that is, approximately in the fasciculus for the face. This location in a transverse projection corresponds to Bitot's section No. 3, and is a little behind Pitres's pediculo-frontal section. The location of the tumor in depth is approximately represented by Fig. 4, made from an oblique transection, corresponding with the frontal section of Pitres.

Pathologist's Report.—The microscopical examination of the tumor, made by Dr. Peabody, pathologist to the hospital, was as follows:

Sections of the tumor show it to be made up chiefly of round and oval cells, with a rather abundant stroma of finely fibrillated connective tissue. These cells vary in size from that of white blood cells to that of three to four times their size. The superficial parts of the growth contain numerous large bloodvessels with very thin walls. There is no perivascularitis. On one side of the tumor there is a thin layer of white matter (visible to the unaided eye) which is distinctly fibrillated, with cells like those of the tumor itself. No glioma cells can be obtained by appropriate treatment. Diagnosis—Sarcoma.

During the operation there was more hemorrhage from the divided scalp vessels than in my opinion should be hereafter allowed. Clamps and ligatures hold poorly in the tough tissues of the scalp, and it is believed that the use of acupressure needles, at least during the operation, would answer better. The operation lasted about one and three-quarters hours, and was prolonged by the difficulties in controlling the hemorrhage from the scalp, dura, and pia mater.

Three or four hours later, when the patient had come out of the ether, it was noticed that he moved his right leg well, and his arm as before. He was slightly aphasic, and his facial paralysis was somewhat more marked. At 10 P.M. Temp. 99°; resp. 24; pulse 132. Given sod. brom. grs. xv. At 11.30 P.M. ordered peptonized milk, \bar{s} j; brandy, \bar{s} j, q. 2 h.

18th. Given hypodermatic of Magendie, \bar{m} ij, at 1.30 A.M. Catheterized at 2.45, 10 ounces of urine drawn. Was very restless during the night. Vomited slightly at 8 A.M. Temp. 102°; resp. 24; pulse 124. Hypodermatic of antipyrin, grs. v, at 11 P.M.; to be repeated every three hours as long as the temperature keeps above 100°. Given milk and lime-water, \bar{s} ij, q. 2 h.

19th. Vomited three times during the morning. Temp., A.M., 100°; resp. 22; pulse 112. Catheterized at 9 A.M. Milk continued as on yesterday. Is fully conscious of everything going on around him. Aphasia more marked than before the operation. Facial paralysis about the same as before operation.

20th. Temp. 99°; pulse 90. The dressings were changed to-day, and as the rubber drain contained clots, suggesting the fact that it did not drain well, it was removed. The one and a half inch thick dressing was pretty well soaked with dried bloody discharge. The horsehair drains were also withdrawn, and only the catgut drain left in. The iodoform tampon was also removed. The scalp was found blistered, owing to irri-

tant effect of the too damp bichloride compresses. This accounted, I think, for the temperature in part at least. Carbolic spray used while dressing was done. Dry sublimate and iodoform dressings applied. Decided improvement in patient this morning; aphasia not nearly so marked.

21st. This morning the temperature was 99.8°, resp. 20, pulse 90. From this date the patient progressed steadily. A second dressing was made on the 27th inst., ten days after the operation, when the whole wound was found healed, save a small spot where the drainage tube had merged. The replaced bone appeared firm. The patient's aphasia had nearly disappeared by this time, and his appreciation of a joke was quite keen. By December 4th he was out of bed, sitting up. The scalp was firmly united, the replaced bone disks solid, and the cranial gap entirely occluded with bone, except at its lower part, where the fragments had been dislodged by the emergence and withdrawal of the iodoform tampon.

SUBSEQUENT HISTORY. [BY DR. SEGUIN.]

The operation was followed by temporary complete paralysis of the right limbs, and nearly complete aphasia. So marked was the last symptom that, for a few hours, we feared that the third frontal gyrus had been injured, but this fear proved groundless. From the day of operation until November 24th, fifteen grains of bromide of sodium were given at bedtime. On November 24th this dose was increased to thirty grains. By a misunderstanding, no bromide was given from November 27th to December 3d, when he was ordered *R.*, Sodii bromidi, ʒjss ; *syr.* aurant. cort. ʒjss ; aqua, ad ʒvj ; one teaspoonful (equal to seventeen grains of bromide) three times a day.

I examined the patient at the New York Hospital on December 8th, twenty-one days after the operation. He was in bed, calm, clear-minded, and in good general condition. No convulsions had occurred. The upper facial muscles act equally well on both sides, except that the left eye cannot be closed independently of the right. In repose, the lower part of the face appears nearly normal. The right lips are weaker and less expressive than the left, the right naso-labial crease has reappeared, and is nearly equal to the left. In speaking or showing teeth, or forming lips to make o sound, the inactivity of the right lips becomes evident. The tongue protrudes almost perfectly straight, going a trifle to the right. In smiling, both sides of the face act equally well. There is no drooling. The left pupil is a trifle larger than the right; both active. Optic nerves and retinal vessels normal.

Upper extremities.—No tremor in extension. The small muscles of the right hand still show some atrophy, though, perhaps, less than at last note. Grasp on dynamometer: right, 22° and 25°; left, 30° and 30°. Coördination is practically perfect. Unbuttoning and buttoning shirt with right fingers alone, is successfully done, though slowly, and a little awkwardly. All voluntary movements are well and quickly made with right foot, coördination (heel-on-patella test) normal. Thoracic and abdominal muscles act well. Circumference of right calf 32 centimetres (12½ inches), of left 31 centimetres (12 inches). No wrist reflex. Knee-jerk high, but equal on two sides. The same is true of the plantar reflex.

Sensibility.—On the face a light touch with finger is equally well felt

on both sides, except that on the lips sensation is, perhaps, more acute on the left side. The points of the æsthesiometer are distinguished on the left cheek and chin at 10 mm., on the right side at from 10 to 15 mm. The greatest difference exists on the upper lip, above moustache. On red surface of lips points are separately recognized as follows: left upper lip, 6 to 8 mm.; right upper lip, 10 to 18 mm. Left lower lip at 4 mm.; right lower lip, 8 to 10 mm. On the tongue, average on the left side, 3 mm.; on the right side, 4 to 5 mm. The patient claims to taste his food properly on both sides of the tongue. Pricking is equally felt on both sides of the face.

Upper extremity.—To light contact there is slight dulness of sensibility on the right hand and forearm, but impressions are correctly localized. Æsthesiometer points are distinguished at between 3 and 4 mm. on pulps of fingers of both hands; a little closer on the left side. Pricking is more acutely felt on the left fingers, hand, and forearm, than on the right. Appreciates heat and cold quickly on right hand. Muscular sense tested with eyes closed. Can maintain right arm in extended position several minutes. Passive movements are quickly and correctly appreciated. Distinguishes small differences in weight in right hand, and recognizes that two silver half dollars, laid one after the other on the right palm are of the same weight. Sensibility of feet and legs normal. Speech is slightly thick, and patient occasionally hesitates for the word; cannot utter it quickly.

Dec. 10. At about 10 A. M. had a convulsive attack. He rang for the nurse, and told her a fit was coming on. She reports that his face was then twitching on the right side, about the nose and beneath the eye; the right forearm was convulsed. Then he became unconscious, and had a general convulsion, the movements being more marked on the right side. Both pupils were dilated and equal; there was internal strabismus of the left eye, and the head was turned to the left. The convulsion lasted about one and a half minutes, and there was a short subsequent coma; pulse 120, but no rise of temperature.

11th. Seems as well as before attack, except some mental depression.

16th. Allowed to walk a little. At 8.15 P. M. had another convulsion.

17th. One month after operation is allowed to go home, in good general condition, and unquestionably better as regards paresis of face and hand.

On the 21st Dr. Godfrey had the kindness to send me the following report: "Mr. B. arrived at 12.45 P. M. I saw him at 1.30 P. M., and found him feeling very comfortable after his journey. Pulse 72; temp. 98.4°; resp. 17. I ordered for him the medicine as you directed (this was a solution the dose of which consisted of Fowler's solution, mv ; iodide of potassium, 15 grains; bromide of potassium, 22 grains; water, ʒij ; to be taken, largely diluted, on waking, after dinner, and after supper). I have ordered him to be kept very quiet for a time, and his wife carries out this instruction very well. He had a slight attack of epileptiform convulsion yesterday, but it was very quickly controlled by the amyl nitrite. His wife says that since returning home he has been more quiet, and his mind more at ease than when in the hospital. *The amount of power exhibited in his right hand and arm is a complete surprise to me, and his speech is better than I have known it in a long time.*"

On Jan. 23, 1888, Mr. B. came to New York to see Dr. Weir and me at my office. He walked in as erect and active as any one, and passed through a trying examination fairly well. Mental action is good, speech

a little slow, but not aphasic (seldom pauses for the word). Has had no marked attack in two weeks; only an occasional twitching of the facial muscles. Has also had a few vertiginous or faint feelings.

The pupils are equal and normal. The upper facial muscles (naturally weak) act fairly well on both sides, less on right. The mouth shows some deviation to the left in repose. In showing teeth, paresis of right cheek and lips becomes evident. In laughing both sides act equally. There is no drooling. On the whole, the face is rather expressionless, somewhat like that of paralysis agitans. The right upper extremity is paretic; grasp, R. 26° and 26° ; L. 35° and 33° . Movements of lower extremity normal.

Sensibility.—To light touch of end of pencil there is no difference between the two sides of the forehead, ears, and neck. On the rest of the face there is a distinct dulness of perception on the right side. The æsthesiometer test shows no difference on the forehead. On the cheeks, around mouth, and on chin, the points are distinguished at greater intervals on the right side; a difference of 50 and 75 per cent. in places. Light touch is less well felt on the right than on the left hand, and the dulness is most marked on the ends of the thumbs and fingers; dorsum and palm equally sensitive. The æsthesiometer, however, reveals no anaesthesia. Sensibility to passive movements and judgments of weight (loaded rubber balls) unimpaired. On February 29th Dr. Godfrey wrote at length about the patient's condition; the following being essential points. No attacks of any sort occurred from Jan. 9th to Feb. 25th (forty-five days), when, after a chill in the night, he had a spasm "mostly limited to the right side," at 8 A. M., followed by paresis of the hand. Since, symptoms of severe remittent fever (pyrexia, jaundice, pain and tenderness over liver, occasional chills) have been present, and have been treated with quinine and calomel, the bromide being continued.

March 8. I went to Bridgeport and examined Mr. B. with Dr. Godfrey. The actual objective symptoms of cerebral disease are as at last note, but the patient is generally very feeble, shows some jaundice, and a little fever. There is much more aphasia than at any time; so much as to render tests of sensibility unreliable. I am of the opinion that this is temporary, and only dependent upon asthenia. From 40 to 60 grains of bromide of sodium to be given, besides the necessary general treatment.

March 19. During an exacerbation of fever there occurred a convulsive attack in the right hand. A similar spasm on the 25th. On the 26th a seizure (well described by his wife) occurred, consisting of only a few clonic flexion movements of the right thumb.

April 3. I again visited the patient, and noted his condition as follows: Mr. B. is calm, clear-minded, and cheerful. Articulation is slightly defective, phonation normal, he occasionally hesitates for a word; in answer to questions, he states that he knows the word he wants, but cannot utter it. The jaundice has almost disappeared; the tongue is clean, appetite fair, axillary temperature 99° , pulse of good strength, about 90 .

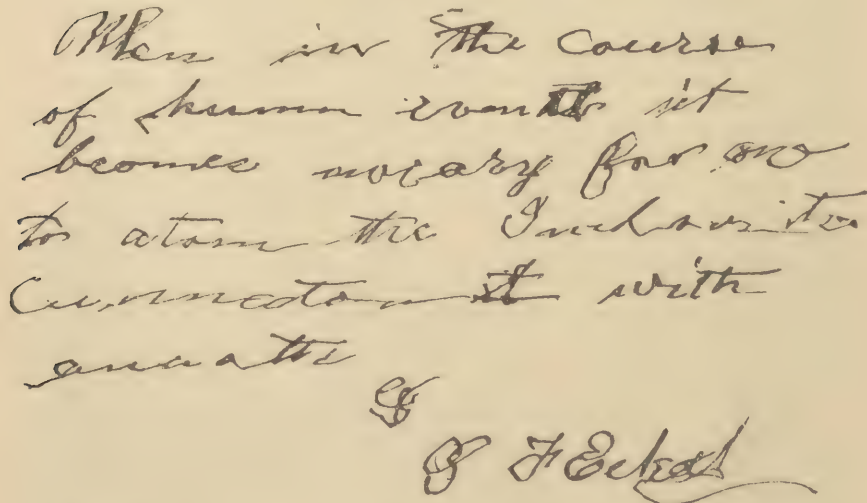
Examination.—Face in repose rather expressionless, which I think is normal. Right lower face less expressive than left. Pupils of medium size, active, the left a little larger. Vision not tested, and fundus not examined. In smiling and laughing (which the patient does heartily at a medical story) both sides of the face act well. The right eye cannot be voluntarily closed alone, whereas the left can. In volitional effort

almost complete inactivity of the right lower facial and buccal muscles. The tongue protrudes almost straight (a trifle to the right). All movements of upper extremities are well and quickly done. The grasp is: R. 11° and 11° ; left 21° and 25° . In extension the *left* fingers exhibit some tremor. The interossei of the right hand are somewhat atrophied. Movements of the leg not tested (patient in bed), but his wife states that he steps well with both legs.

Sensibility.—Face not tested. Declares most positively (to repeated questions) that the right hand no longer feels “numb.” Feels the lightest touch on right fingers and hand, and with eyes closed he distinguishes consecutive contacts with coarse bed-cover, thin handkerchief, and a sheet of paper. *Esthesiometer* points are differentiated at about three millimetres on left finger-tips, and at four on right finger-tips. Feels temperature equally well on both hands (and fingers). Muscular sense: with eyes closed, recognizes such objects as a key, a knife, and a piece of money placed in his right hand. A twenty-dollar gold piece being placed in it, he calls it a dollar; a half-dollar he calls a quarter, but he recognizes the difference between the weight of a half-dollar and that of a quarter-dollar. With rubber balls loaded to a difference of half an ounce up to four ounces, he recognizes differences quickly.

Mrs. B. states that since the return home convulsive movements have not appeared in the cheek.

FIG. 5.



When in the course
of human events it
becomes necessary for us
to attain the Independence
of our nation it with
gratitude
of
J. F. Eckel

Reproduction of Mr. B.'s writing April 4, 1888, showing agraphic as well as simple motor defects.
(The patient never wrote a very good hand, and was not a good speller.)

On April 4th Dr. Godfrey made some tests of the patient's ability to write. The few short attempts made caused great fatigue. By simple dictation next to no result was obtained. A copy of the opening paragraph of the Declaration of Independence was placed before the patient

and was partly copied, partly written by dictation, with the copy before him. The result, represented on page 36, shows faults due to the lack of strength and coördination, but also distinctly agraphic faults. There was no alexia.

It thus appears that nearly five months after the removal of Mr. B.'s cerebral tumor there is no very positive evidence of recurrence of the growth. The increased aphasia and agraphia may possibly indicate the invasion of more cerebral tissue by sarcomatous cells; but this is not so certain, because the aphasia has greatly diminished from March 8th, and it is impossible to determine how much the remaining debility, due to the remittent fever, may be responsible for symptoms now present.

It is greatly to be regretted that the normal course of the case should have been so obscured and modified by an intercurrent disease.

POST-SCRIPTUM.—*June 6th.* Mr. B. goes to Europe for a stay of two or three months. He comes to my office alone, and is himself attending to the details of the voyage. General health has greatly improved; is stout and florid. Attacks as follows, since last note: April 24th, slight clonic spasm in right hand; 28th, had a convulsion, beginning by local spasm in hand as usual, no biting of tongue; 30th, twitching of right thumb. May 14th, subjective spasm in right cheek and tongue, speech suspended for a few minutes; attack witnessed by wife, who says there was no visible spasm or impairment of consciousness; 26th, jerking of right thumb for a few moments. No return of fever; only occasional slight headache; all functions normal. Speech has varied in freedom from day to day.

Examination.—Apparently in perfect health; pulse 84. Speech a little slow, pauses for a word occasionally, but usually finds it. No headache to-day. Thinks that right hand has become weaker (which is an error), and states that a wooden or dead feeling (not formication) is present in fingers, most in medius, not in thumb, or palm, or in face. Drools occasionally from right buccal angle. Paresis of right lips and cheek, as at last note. The tongue is straight, but trembles and looks somewhat shrivelled, as in some cases of dementia paralytica. Grasp: right hand, $19\frac{1}{2}^{\circ}$, 20° , 22° ; left hand, 33° , 25° , 28° . Coördination of hand perfect. Stands perfectly well with eyes open and closed, on one or both feet; walk normal. Patellar reflex normal, and equal on both sides; no wrist reflex. Sensibility is normal to touch, temperature normal, pricking on finger-tips and hands. Aesthesiometric limits on pulps of right fingers, 3 mm. Can distinguish differences in weight of only a few grains in right hand, and is fully conscious of all passive movements. Vision = $\frac{20}{xx}$; optic nerves normal.

Treatment.—On May 9th was given (in place of simple bromide solution) a solution of hydrate of chloral 7.50 gm., sodium bromide 37.50 gm., water 200 gm., each teaspoonful containing 3 grains of chloral and 12 grains of bromide of sodium. Dose, 2 teaspoonfuls on rising, 1 teaspoonful at midday, $1\frac{1}{2}$ teaspoonfuls after evening meal; equal to about

4.5 gm., or 67 grains of the anti-epileptic salts per diem. Also, more or less regularly, a pill containing arsenious acid 0.001, podophyllin 0.004, ext. belladonna 0.015, quin. sulph. 0.20, after each meal. This treatment is to be continued faithfully while away. Is to avoid over-exertion, excitement, and exposure to great heat.

REMARKS UPON THE DIAGNOSIS WHICH SHOULD BE PRELIMINARY TO
THE SURGICAL TREATMENT OF CEREBRAL TUMORS.

[BY DR. SEGUIN.]

The surgeon's attempt to remove a cerebral tumor, and thereby prolong, or even in some cases save life, must necessarily be based upon an accurate diagnosis of the lesion. The modes of examination and methods of reasoning necessary to attain such a diagnosis being so unlike the methods of diagnosis employed by surgeons, and requiring so much special experience in neurology, the services of both a physician and a surgeon are required. The medical examination is the necessary preliminary to an operation, and a neurologist can hardly possess the surgical skill and experience which are required, not simply to remove the tumor, but to insure a reasonably certain aseptic condition of the wound and render the operation of trephining in itself not specially dangerous.

The medical diagnosis of a case of supposed tumor of the brain should, before an operation is attempted, be carefully worked out in not less than five lines of inquiry, or secondary diagnoses. 1. The diagnosis of tumor within the skull, and more especially in or upon the cerebral hemispheres. 2. The diagnosis of the exact location of the tumor. 3. The diagnosis of the depth of the tumor; whether it be cortical or sub-cortical. 4. The diagnosis of the solitude or multiplicity of the tumor. 5. The diagnosis of its nature.

First. THE DIAGNOSIS OF TUMOR OF THE CEREBRUM.

As a rule, this is accurately made by the experienced physician. The gradual development of symptoms, such as headache, convulsions local or general, paresis, and paralysis, co-extension of these symptoms, moderate anæsthesia, choked disk, hemianopsia, stupor, coma, slow pulse, leave hardly any room for doubt. The grouping of symptoms is most various, and largely depends upon the location of the growth, upon its size, and upon personal tendencies of the patient. Anæsthesia is rarely great, headache may be entirely absent, and, in my experience at least, choked disk is not the rule in strictly cerebral tumors. We must, of course, make allowance for exceptional cases, such as those which present only choked disk and an occasional general convulsion, those in which an apoplectic attack is the first symptom that seriously attracts

attention, etc. I think that I shall not overstate the case in saying that while the most experienced and careful observer may find at an autopsy a tumor which had caused no symptoms, yet when the symptoms of tumor are present, almost every practitioner should be able to make the diagnosis.

*Second. THE DIAGNOSIS OF THE TOPOGRAPHICAL LOCATION
OF THE TUMOR.*

This diagnosis is arrived at by an application of our empirically acquired knowledge due to the clinical and post-mortem studies of Broca, Hughlings Jackson, Charcot, Wernicke, Nothnagel, Exner, Luciani, and many other observers (several of them our own countrymen), and of physiological laws of cerebral action, as elucidated by the researches of Hitzig, Ferrier, Munk, Putnam, Franck, Horsley, and others. To discuss the subject thoroughly is impossible in a paper like this, and I must ask to be allowed to state the bases of a solid localization diagnosis in a summary way.

1. There are parts of the cerebrum which are in a certain sense inexcitable, and lesions of which produce no special or localizing symptoms. When tumors are located in these areas of the brain, the patient exhibits only general symptoms of cerebral disease, such as headache, diffused or localized, general convulsions; pressure symptoms, such as reluctant full pulse, perhaps slow pulse, choked disk, blindness, stupor, with or without partial hemiplegia and hemianæsthesia, dysarthria, dysphagia, coma, with hyperpyrexia, and Cheyne-Stokes respiration at the end. The parts of the cerebrum which belong to this category are (*a*) the frontal lobes strictly speaking, except the caudal extremities of its external gyri, more especially the second and third; (*b*) the apex and base of the temporal lobes on both sides, and the whole of the lobe on the right side; (*c*) the external and basal aspect of the occipital lobes; (*d*) parts of the parietal lobes; and (*e*) the central ganglia. The fasciculi of medullary substance connecting those parts with the base of the brain, and with other parts of the cerebrum (commissural fibres) are included as inexcitable parts. Progress in pathological and experimental knowledge will, doubtless, reduce these inexcitable areas, but I think that I have stated them as a conservative view of cerebral physiology now dictates.

2. We have left two irregular divisions of the cerebrum, lesions of which give rise to special, definite, localizing symptoms; these are, first, the excitable or motor zone, cortex and attached fasciculi; and second, the known sensory zones, with their fasciculi. The fasciculi from all these zones converge, and are crowded together at the knee and caudal portion of the internal capsule, as it passes ventrad between the basal ganglia, and leaves the cerebrum.

The motor zone comprises in its cortical aspect the following convolutions on both sides of the brain: the caudal extremities of the third, second, perhaps of the first frontal; the pre- and postcentral gyri, and their prolongation within the longitudinal fissure, known as the paracentral lobule. These gyri and portions of gyri are all placed dorsad of the fissure of Sylvius, and are grouped about the fissure of Rolando. That the folds of the insula (island of Reil) have motor properties, is probable. These parts all receive their supply of arterial blood through one channel, viz., the middle cerebral artery; and all of them (with the exception of the insula) can be accurately mapped out on the head by means of one or another of the several methods of cranio-cerebral topography. The subjoined diagrams illustrate the determination of the position of the motor zone by Broca's method.

The motor zone, as its name implies, has motor functions, and has an anatomical and physiological connection with the muscular apparatus of the opposite side of the body, as follows: The base of the third frontal gyrus (left side) with the delicate movement of speech; it also, and the adjacent base of the precentral gyrus with the lingual muscles, the base of the second frontal gyrus at its confluence with the precentral, with the muscles of the face; the middle third of the precentral gyrus with the muscles of the forearm and hand; the upper third of the pre- and postcentral gyri with the muscles of the arm and shoulder; the ends of the pre- and postcentral gyri (paracentral lobule) with the muscles of the foot, leg, and thigh. Probably the muscles of the hip and abdomen are innervated from the bend of the above-named gyri as they dip down into the longitudinal fissure. Those portions of the motor zone, whose limits are probably not definite, are designated as "motor centres." Thus we have, from below upward, the centres for speech, for lingual, manual, brachial, scapular, abdominal, femoral, crural and pedal movements. A centre for ocular movements doubtless exists, but it has not yet been determined; it is quite certainly not in the second frontal gyrus, as claimed by Ferrier and Horsley. Another questionable motor centre is that for laryngeal movements, which is being sought for in the caudal extremity of the right third frontal (homologous with the speech centre on the left side, in right-handed persons). The entire motor zone is easily reached by trephining, the only obstacles in the way being the middle meningeal artery, and, in operations near the vertex, the superior longitudinal sinus.

Of the sensory zone we have as yet positive knowledge of only two of its centres or areas, a probable knowledge of a third, and a suspicion of a fourth. On the left side of the cerebrum the first or dorsal temporal gyrus appears to be the organ for vocal or linguistic audition (A U D on Fig. 7). Upon the inner, mesial aspect of each occipital lobe is a trian-

gular gyrus which has a wonderful function; each cuneus receiving impressions, probably through direct fibres, from the homologous half of each retina on the same side of the median line. Perhaps the first

FIG. 6.

Bregma.

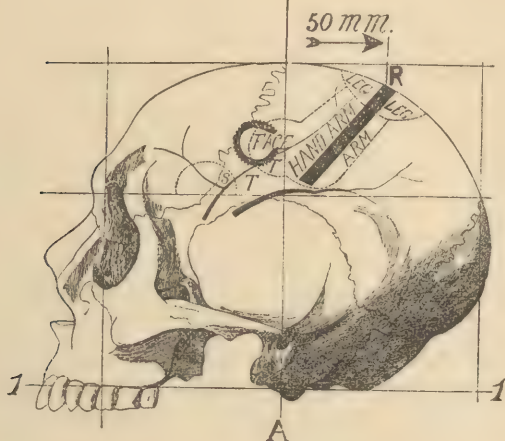
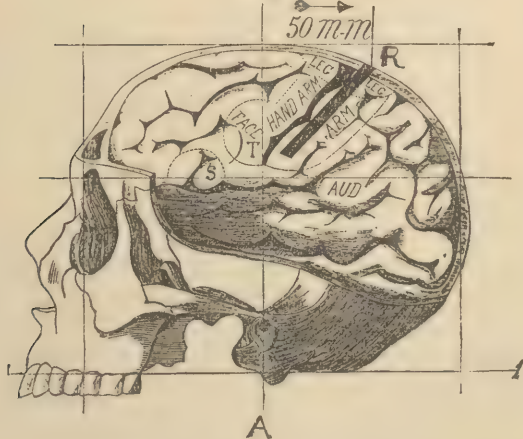


FIG. 7.

Bregma.



Figs. 6 and 7.—Simplified cranial and cerebral diagrams, with Broca's lines. For detailed explanation of these diagrams see Pepper's *System of Medicine*, vol. v. pp. 91-93, and Gross's *Surgery*, vol. ii. p. 42. In Fig. 6 the crescentic mark indicates Dr. Weir's first trephine opening.

occipital gyrus should be added to this zone for half-vision. That the external aspect of the occipital lobes has some relation to $\frac{1}{2}$ -vision is probable, but not yet fully demonstrated in man. The third division

or area of which we have knowledge, a preliminary knowledge only, is an uncertain portion of the parietal lobe, probably the inferior parietal lobule, on both sides. This area, we have some reason to believe, receives and registers impressions of muscular sense, or motor residua. The first and third of these areas of the sensory zone are fed, like the motor zone, by branches of the middle cerebral artery, while the second (cuneus and adjacent occipital gyri) is supplied by the occipital artery, a branch of the posterior cerebral. Thus, in the sensory zone, we have a centre for vision, a centre for the audition of language, and a centre for muscular sense. The cortical connections of the fibres and fasciculi for common sensibility, for taste, for smell, and for simple sound-hearing are as yet unknown: perhaps the mesial extremity of the temporal lobes is the centre for smell. The surgeon can readily expose and treat the three known centres enumerated above.

Effects or symptoms of tumors in the motor or excitable zone of the cerebrum. Following the all-important distinction advanced by Brown-Séquard nearly thirty years ago, and which has been a guide-star to successful diagnosticians, we are to distinguish symptoms due to irritation or excitation of a part from those due to its destruction; in other words, there are irritative symptoms and destructive symptoms when a lesion exists and develops in the motor and sensory areas of the cerebrum.

In obedience to the laws of physiological or functional localization, to the pathological law of Brown-Séquard, and as we now know from empirically acquired post-mortem evidence, tumors of the motor zone of the brain are characterized by a somewhat specific symptom-grouping, according to the primary location of the growth. Later the symptom-group becomes enlarged and obscured by extension of the tumor, its action upon more than one motor centre, and by more or less direct effect upon adjacent parts.

I. *Tumors of the motor zone.*

(a) Tumors of the caudal extremities of the third frontal gyrus (on the left side in dextrous persons) produce at first slowness of speech and paroxysmal motor aphasia. Their extension toward the rest of the motor zone causes paresis and convulsive movements of the tongue, face, and upper extremity on the opposite side. Later still these symptoms, motor aphasia, spasmodic movements, and paralysis of the tongue, face, and upper extremity become more frequent, and, finally, permanent; with occasional spasms.

(b) Tumors of the basal ends of the pre- and post-central gyri cause at first convulsive movements, or paresis, or both, of the opposite half of the tongue; later, paroxysmal motor aphasia, spasm, and paresis of the face and upper extremity; last, complete paralysis of one-half of the

tongue, of the face, and upper extremity, and permanent aphasia, with occasional convulsions ("Jacksonian" movements).

(c) Tumors of the caudal extremity of the second frontal gyrus, where it becomes confluent with the lower third of the pre-central gyrus, produce at first paresis with convulsive movements (or *vice versa*) of the facial muscles of the opposite side; later, the same symptoms, with the addition of more or less motor aphasia, paresis of one-half of the tongue, paresis and spasm of the upper limb (more especially the fingers); lastly, permanent paralysis of the face, half of the tongue, and hand, permanent aphasia, and occasional spasms (*vide* the case reported).

(d) A tumor starting in the lower middle third of the pre-central gyrus first reveals itself by spasm and paresis of the opposite thumb and finger (and whole hand and forearm occasionally). After further growth the irritative and destructive symptoms appear in the face and tongue, and more or less marked aphasia occurs; the paresis of the hand and forearm becoming complete paralysis. A peculiarity of lesion of this centre, not as yet proven to exist in lesion of the other centres of the motor zone, is a pronounced subjective numbness and slight though usually demonstrable tactile anaesthesia. This fact, which in its restriction to effects of lesions of the centre for the hand, has been overlooked or indefinitely treated by authors, is perhaps explicable by that other fact that the motor education of the hand and forearm is more largely acquired through conscious sensory impressions. The motor functions of the tongue, face, and leg, are more automatic in their genesis; or, in other words, are performed with much less consciousness of motor effort. To put it in another way, the delicate movements of the fingers and hand are much more sensori-motor, and consciously motor than are the movements of other muscular groups; those of the facial muscles coming next.

(e) Tumors of the upper middle third of the pre-central gyrus (and perhaps of the post-central also) early cause symptoms in the muscular apparatus of the upper arm and shoulder. Later the spasm and paresis extend to other parts, according as the growth extends ventrad or dorsad. In the former case the forearm and hand, the face, half of the tongue, show symptoms, and, lastly, aphasia may occur, though rarely complete. If the tumor grow dorsad, toward the longitudinal fissure, spasm and paresis, later paralysis, show themselves successively in the thigh, leg, and foot.

(f) Tumors of the upper third, or top of the pre- and post-central gyri, and of the paracentral lobule at first cause symptoms, convulsive and paretic, in the thigh, leg, or foot. There is every reason to believe that in man the special subcentre for the hip and thigh is the cortex of the central gyri where they bend over to form the paracentral lobule, while the lobule itself innervates the leg and toes. Later, by extension

of the morbid growth, there are symptoms in the arm and hand, rarely in the face, probably never aphasia (except in the rare cases in which a peculiar vitality of the patient permits of the growth of a colossal tumor). Or, there may be (though I do not know of any tumor case on record, yet, at least, one traumatic case exists¹) invasion of the crural centre of the opposite hemisphere, producing paralysis, with spasm or without spasm, of both legs (pseudo-paraplegia).

These propositions, which are based on the completed study of many cases of cerebral tumor, have served and will, I think, continue to serve as safe guides to the diagnosis of the location of a tumor in the motor zone.

One word as to the local and general spasms which are produced by lesions thus placed. Usually the first spasm (clonic or tonic) is limited to a small region, face, hand, arm, shoulder, toe, or leg. The patient is perfectly conscious and watches the "Jacksonian" spasm with curiosity or amusement. Subsequently the spasm shows a marked tendency to extension, in the following serial order: If beginning in the facial muscles, it extends to the hand, to the arm, and, lastly, to the leg of the same side. If starting in the fingers, it next affects the face and upper arm, lastly the leg. When the lesion is on the left side temporary aphasia is primary, or is superadded according to the exact seat of the tumor. If the convulsive movements are first shown in the foot, they extend to the leg and thigh, to the hand and arm, lastly to the face. In all these mono- or hemi-spasms the movements are irregularly clonic and tonic, and consciousness is preserved, even when aphasia occurs. If the peculiar irritating action continue longer, convulsions appear on the same side as the tumor and consciousness is lost, showing that the irritation affects both hemispheres. The fully developed generalized spasms with loss of consciousness exactly resemble the seizures of so-called idiopathic epilepsy; so that the natural history of cerebral tumors shows us insensible transition-forms between the smallest localized convulsions and typical "epileptic" ones. It is most interesting to note that the results of physiological experiments upon the motor zones of animals are practically identical. The serial extension of spasm produced by prolonged electrical excitation of one motor centre has been determined by Albertoni, Luciani and Tamburini, Bubnoff and Heidenhain, Franck and Pitres, Unverricht, and Rosenbach, from 1876 to 1883. These results have been confirmed by many subsequent observers, and more especially elaborated by Franck in his latest work (1887).

It will be noticed that in pathological cases and in experiments the symptoms, which are due to a small lesion or to a very limited electrical irritation of a motor centre, are at first restricted to the small muscular

¹ Macleod: *Notes on the Surgery of the War in the Crimes*, 1885, pp. 212-16

group which this centre controls. This early limited spasm or paresis, I have long looked upon (even before the physiological demonstration) as the key to a correct localization diagnosis. It is indispensable to sift the patient's account of his first symptoms, and obtain the corroboration of an eye-witness when practicable, in order accurately and positively to determine the location, nature, and extent of the first symptom, which in many cases is rapidly overlaid and obscured by others. I propose to call this the *signal-symptom* of cerebral tumor. Since the time of Hughlings Jackson's first clinical observation to the present time, very numerous instances of a clearly marked signal-symptom (paresis or spasm) have been recorded, with the post-mortem proof of its dependence upon a localized lesion in one of the cortical motor centres or associated fasciculi. Thus, we have all seen cases of cerebral tumor in which the first localizing symptom was a spasm or paresis of one side of the face, one hand, or one leg, and also motor aphasia. I hope soon to present a detailed study of the signal-symptom of cerebral tumors, its genesis, and extreme importance for diagnosis.

II. *Tumors of the sensory zone.*

Lesions of those areas of the sensory zone whose functions are best known to us, viz., the centres for half-vision and for audited speech, manifest their presence almost exclusively by the so-called destruction symptoms. Irritation symptoms probably occur, but we have little knowledge of them. This subject might tempt one into a lengthy discussion, but, on account of want of space, I must limit myself to a bare statement of the main facts.

(a) A patient presenting, besides the general symptoms of an intracranial growth, such a specific symptom as verbal deafness, without marked hemiplegia, hemispasm, or hemianæsthesia, probably has a tumor involving the left superior or dorsal temporal gyrus, or its subjacent white fasciculus. The symptoms produced by extension of this growth would be mostly sensory, such as paræsthesiæ, loss of muscular sense, and later anæsthesia of parts on the opposite side of the body.

(b) A patient who has headache, vomiting, choked disk, dulness tending to stupor, increasing hemianæsthesia, with lateral hemianopsia (dark half-fields on same side as anæsthesia), without hemispasm or hemiplegia, quite certainly has a tumor in the white substance of the occipital lobe.

(c) If, with the above-named general symptoms of cerebral tumor, we find lateral hemianopsia almost alone as a localizing symptom—*i. e.*, without hemispasm, hemiplegia, and hemianæsthesia—there is almost certainly a tumor on the inner or mesial aspect of the occipital lobe, opposite to the dark half-fields, compressing and destroying the cuneus. The symptoms to be expected from the extension of such a tumor are: from its growth upward, weakness and even paralysis of the lower

extremity of the same side as the dark half-fields; and from its downward growth, symptoms of injury to the cerebellum and lobi optici. That such a diagnostic statement is not fanciful, may be proved by the findings in the first tumor case operated upon by Dr. Weir in the spring of last year.¹ The location of this tumor upon the cuneus, or near it, had been diagnosticated sixteen months before the operation.

Indeed, I am prepared to assert that tumors involving the cuneus, or its subjacent fasciculus, together with other fibres of the caudal division of the internal capsule, are now as easy of correct diagnosis as are tumors of the various motor centres.

Third. THE DIAGNOSIS OF THE DEPTH OF THE TUMOR.

Equally interesting, and important for successful operative interference in cases of cerebral tumor, is the question, whether we are now in a position to tell whether a tumor of the motor zone is cortical or subcortical—the diagnosis of the depth of the tumor. Let us see what observations upon tumor cases teach us in this respect. If such a diagnosis be possible, it will have to be made by a consideration of the following symptoms:

(a) Nature and location of the signal-symptom, presence, and order of appearance of spasm or of paresis; (b) presence or absence of headache; (c) changes in local cranial temperatures. The other symptoms of cerebral tumor are of much more general significance, and cannot, I think, be utilized for this third diagnosis.

(a) The nature and location of the signal-symptom.

In this connection we can invoke the assistance of physiology, and learn whether experiments show any positive differences between irritation and destruction of the cortex, and of subcortical white substance in the motor zone. The credit of first demonstrating that convulsive movements in the opposite limbs may be produced by faradization of the white substance, after excision of a cortical motor zone, belongs to Dr. J. J. Putnam, of Boston.² Since, almost all experimenters have agreed that faradization of cortical centres, and their subcortical fasciculi, produces spasm in the parts which the centres innervate; and even low down in the internal capsule (Franck, Beevor, and others) the excitability of isolated fasciculi for the tongue, face, etc., can be demonstrated. We must next ask, Is there any difference in the form or graphic expression of local spasms produced by irritation of a cortical centre, and that produced by irritation of its dependent fasciculus after excision of the cortex? Here we may hope for a scientific guide in making our third diagnosis. The latest authoritative answer to this question is to be found in the remarkable work of F. Franck³ on the motor functions of the

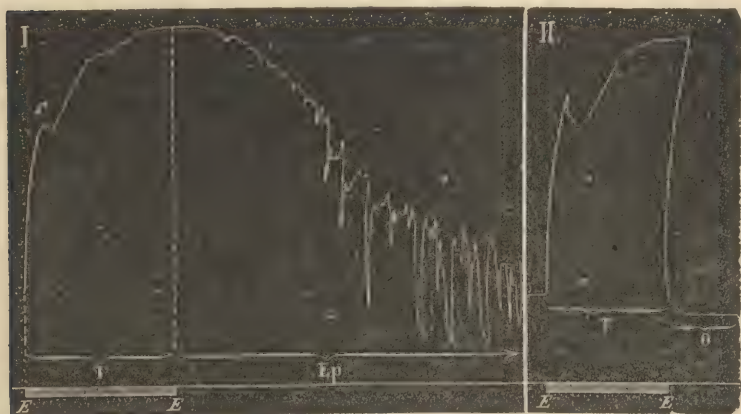
¹ Medical News, April 16, 1887.

² Boston Med. and Surg. Journal, July, 1874.

³ Op. cit., pp. 99–109.

brain, published last year. This experimenter has determined the following important facts, which have been corroborated by other observers in certain directions. 1st. There is greater "delay" in the occurrence of muscular contraction after the application of the electric current to the cortex, than there is when it is applied directly to subjacent medullary fasciculi. 2d. Electrical excitations of the medullary fasciculi produce only tetanic contractions, ceasing abruptly, or nearly so, when the excitation stops. When the motor cortex is excited, however, we obtain a tetanic (or tonic) contraction while the current passes, lasting a little while after it ceases, and followed by clonic convulsive movements; in other words, an epileptiform convulsion. Consequently, Franck proposes the following law: "The hemispheric white substance, in the centrum ovale, or in the internal capsule, is devoid of epileptogenous property, whereas the cortex above possesses this property." (This applies, of course, only to the cortex and white substance of the motor zone.)

FIG. 8.



From Franck, *op. cit.*, p. 101. I. Complete epileptiform spasm produced by electrical irritation of a cortical motor centre. II. Simple tetanic spasm produced by electrical irritation of subjacent white fasciculus. E, E., duration of electrical application. T, tetanic or tonic spasm. Ep, clonic or epileptiform spasm. O, absence of spasm.

Does the study of cases of lesions of the human motor cortex and associated fasciculi furnish corresponding data for diagnosis? We must answer, No. The types of spasms observed in cases of cerebral tumor are constantly variable in the same subject. We obtain simple tonic seizures, tonico-clonic and clonic spasms are observed, as well as typical epileptic attacks commencing by tonic spasm of a small part (signal-symptom). Further study of these phenomena may throw more light upon the differential diagnosis between cortical and subcortical tumors;

but we must not be too sanguine in this matter, because a source of confusion will always exist in such cases, viz., that in cases of subcortical tumor the cortex governing the affected fasciculus is still present and active, and that the irritation of the tumor may act both centripetally and centrifugally. In the former case the irritation of the tumor would produce "discharges" or spasm dependent upon cortical irritation (true epileptiform attacks), while in the latter case simple tetanic or tonic spasm due to excitation of the medullary substance alone would appear. It is highly probable that in human subjects this twofold excitation takes place, thus explaining the complicated and variable spasmodic movements which are observed. We conclude that at the present time it is impossible to distinguish a cortical from a subcortical tumor by the character of the convulsions observed.

Turning to the purely clinical and empirical aspects of this question, let us see what authorities say. The great majority of recent writers upon nervous diseases do not even attempt the diagnosis of cortical from subcortical lesions. Among these are (in chronological order); Charcot,¹ Pitres,² Wilkes,³ Grasset,⁴ Hammond,⁵ Ross,⁶ Strümpell,⁷ Webber,⁸ Bastian,⁹ Liebermeister,¹⁰ Starr,¹¹ Jastrowitz,¹² Wood,¹³ Seeligmüller,¹⁴ Gowers.¹⁵ Several of these authors, however, give some data bearing on this diagnosis, Gowers stating that lesions of the white substance give rise to local convulsions only when they are situated immediately under the cortex. The following authors discuss the problem more or less: Nothnagel,¹⁶ Bernhardt,¹⁷ Osler,¹⁸ Mills and Lloyd.¹⁹ The first author of the second series treating of lesions of the centrum ovale, more especially of clonic spasms produced by them, says: "They are similar in their characteristics to those which are produced by cortical lesions;"²⁰ that they may be limited to one member permanently, or may begin in one member and extend to others on the same side of the body without loss of consciousness. If the convulsions pass over to the other side,

¹ *Leçons sur les Localisations dans les maladies du cerveau.* Paris, 1876.

² *Recherches sur les lésions du centre ovale, etc.* Paris, 1877.

³ *Lectures on Diseases of the Nervous System.* London, 1878.

⁴ *Traité Pratique des maladies du système nerveux.* Paris, 1881.

⁵ *A Treatise on the Diseases of the Nervous System.* Seventh ed. New York, 1881.

⁶ *A Treatise on the Diseases of the Nervous System.* Amer. ed. New York, 1881.

⁷ *Lehrbuch der speciellen Pathologie u. Therapie, Bd. ii.* Leipzig, 1884.

⁸ *A Treatise on Nervous Diseases.* New York, 1885.

⁹ *Paralyses, Cerebral, Bulbar, and Spinal.* Amer. ed. New York, 1886.

¹⁰ *Vorlesungen über specielle Pathologie u. Therapie, Bd. ii.* Leipzig, 1886.

¹¹ *Intra-cerebral Tracts.* New York Medical Record, 1886, i. 174.

¹² *Deutsche med. Zeitung*, 1887, p. 1098. ¹³ *Nervous Diseases.* Philadelphia, 1887.

¹⁴ *Lehrbuch der Krankheiten des Rückenmarks und Gehirns, Abth. ii.* Braunschweig, 1887.

¹⁵ *A Manual of Diseases of the Nervous System, vol. ii.* London, 1888.

¹⁶ *Topische Diagnostik der Gehirnkrankheiten.* Berlin, 1879.

¹⁷ *Symptomatologie u. Diagnostik der Hirngeschwülste.* Berlin, 1881.

¹⁸ *Medical News*, January 19, 1884.

¹⁹ *Pepper's System of Medicine, art. Tumors of the Brain, vol. v.* Philadelphia, 1886.

²⁰ *Op. cit.*, p. 373.

consciousness is lost and the attack resembles an attack of epilepsy. Yet the author has never seen a case in which a strictly subcortical lesion produced hemispasm, and he considers Pitres' seventeen cases as all open to criticism. He considers it doubtful if a truly subcortical lesion can produce monospasm or hemispasm. His third law relative to lesions of the centrum ovale is substantially as follows: Even if focal symptoms are present, it is impossible to conclude that there is a lesion limited to the white substance, as these symptoms are identical with those produced by lesions of the corpora striata and of the cortex. In other words, the diagnosis of a medullary lesion is at present impossible (1879).¹

Bernhardt,² speaking of tumors in the white substance of the parietal lobes (including the motor gyri), states that in fifteen out of twenty-nine cases convulsions, local or general, occurred. In the cases of local spasm, paralysis preceded or followed the spasm. The symptoms of this class exactly recall those observed in connection with cortical tumors.

In another place³ he repeats that subcortical and cortical tumors of the parietal lobes (which include the central gyri) produce similar motor symptoms, viz., local convulsions preceding or succeeding paralysis. The differential diagnosis is extremely difficult.

Osler⁴ reports a case of tumor under the paracentral lobule, which comes nearer to meeting the requirement of a test-case. The growth was found mostly in the white substance; its size was 17 by 15 mm.; it was distant 8 mm. from the left paracentral gray matter, 10 mm. from the top of the brain, and 15 mm. from the central gyri, but the tumor touched the gray matter at several points. The signal-symptom was a spasm, limited to the right extremities, first in the arm, second in the leg, and last in the face. Paresis followed. In its early period this growth was probably strictly medullary.

Mills and Lloyd⁵ express themselves more fully. "As the white matter of the centrum ovale and capsule represents simply tracts connecting cerebral centres with lower levels of the nervous system, with each other, or with the opposite hemisphere, lesions of this portion of the cerebrum will closely resemble those cortical lesions to which the tracts are related. Those (lesions) situated in the white matter in close proximity to the ascending convolutions give symptoms closely resembling those which result from lesions of the adjoining cortical motor centres. In the cases of Osler, Pick, and Seguin, parietic symptoms in the limbs of one side of the body, with or without loss of consciousness, were marked symptoms. In two of these cases some paresis preceded the occurrence of the spasms. They did not, however, fully bear out the idea of Jack-

¹ Nothnagel: *Op. cit.*, p. 377.

² *Op. cit.*, p. 128.

³ Medical News, Phila., January 19, 1884.

⁵ *Op. cit.*, p. 1059.

³ *Op. cit.*, pp. 131, 132.

son that the hemiparesis or hemiplegia in tumors of the motor tract comes on slowly before the appearance of spasm."

Hughlings Jackson¹ has placed on record a case which overthrows the dictum that tumors of the cortex invariably produce convulsions first. Case of traumatic external tumor on left side of the head of eighteen years' standing. Six months before observation severe local pain appeared in this region, and there developed a gradually increasing paresis of the right leg, arm, and face (in order); optic neuritis; but *no convulsions*. The autopsy showed an internal tumor pressing upon the motor zone. Jackson adds: "In all cases of very slowly coming on hemiplegia I have seen, the tumor has always been of (in) the motor tract. That disease of the surface—even very limited disease thus placed—will cause hemiplegia, is well known, and is illustrated by several cases of this series; but in all cases seen save this one, the hemiplegia has followed a convulsion." Consequently it appears that Jackson, in 1874, considered it a law that cortical lesions produced convulsions first, paresis second.

In my own records I find the following data in three cases of cortical and one of subcortical tumor. In the subcortical tumor,² which was just beneath the top of the central convolutions, latero-dorsad of the paracentral lobule, paresis preceded spasm. In the case we present, on the contrary, spasm preceded paresis.³ With respect to the three cases of cortical tumor of the motor zone, in one,⁴ local spasm probably preceded paralysis; in the second,⁵ paresis and spasm appeared simultaneously in the left hand; and in the third,⁶ monospasm occurred first. These five cases, and other cases by different authors, bear out the preceding statements that, at present, no law of motor symptoms can be formulated for cortical and subcortical tumors.

(b) Can the cortical or subcortical location of a tumor be determined by the presence or absence of localized headache? There has long existed a somewhat well-founded notion that lesions of the brain are more painful in proportion as they are nearer to the dura mater. Yet a study of recorded cases of tumor go to show that such remarkable exceptions occur, that the rule is not one to be depended upon, though it has a certain corroborative, or secondary, value. Only a few cases need be cited.

In Osler's⁷ case of subcortical tumor headache is not mentioned, while

¹ Medical Times and Gazette, 1874, ii. 152.

² A Third Contribution to the Study of Location of Cerebral Lesions, Journal of Nervous and Mental Diseases, June, 1887.

³ It is doubtful if this tumor was, strictly speaking, subcortical.

⁴ Contribution to the Study of Localized Cerebral Lesions, Seguin's Opera Minora, p. 215, New York, 1884.

⁵ Second Contribution to the Study of Localized Cerebral Lesions. *Idem*, p. 495.

⁶ *Idem*, p. 499.

⁷ Medical News, Philadelphia, January 19, 1884.

in the case of Baudot (cited by Pitres)¹ of a tumor in the middle portion of the centrum ovale, with symptoms of lesion of the motor zone, severe headache was an early symptom. Russell² reports a case of cancerous tumor of the right frontal lobe, involving both white and cortical gray substance, in which "slight headache" occurred, and Hughlings Jackson³ publishes a case of tumor compressing the cortex of the motor zone, in which severe local pain (not a common headache) was a marked symptom during the first six months.

Bernhardt⁴ states that headache was positively absent in 2 out of 36 cases of tumor in the white substance of the frontal lobes, and in 3 out of 29 cases of tumor in the parietal lobe. As regards the medullary substance of the occipital lobe, there is no observation in which it is stated that headache was absent, but in 4 out of 15 cases pain is not mentioned among the symptoms. He considers pain as a symptom of no special value for localization; it may even be on the side opposite the tumor.

Perhaps a more certain indication is the presence of tenderness to percussion. A case seen by me last autumn, in consultation with Dr. Obendorfer,⁵ well illustrates the small value to be attached to these two symptoms. A man, æt. fifty-six, had suffered from obscure urinary difficulties, including hæmaturia; a few months before death he developed symptoms of cerebral compression, headache, drowsiness, slow pulse, but no choked disk. For several weeks the head-pain was localized over the right frontal region, in a space about four centimetres (1½ inches) in diameter. This region was also tender when I saw the patient. Surface temperature carefully taken with an Immich metallic thermometer, gave on right frontal bosse 96.5°, on the left 97°. Consequently, the sensory symptoms, together with the absence of hemispasm and hemiplegia, of hemianopsia, were in favor of the existence of a tumor on or in the right frontal lobe; though the absence of increased local temperature argued otherwise. The autopsy made in December, 1887, by Dr. Waldstein showed a large cancerous tumor of the kidney, and two secondary tumors in the brain; one in the right temporal, the other in the right occipital lobe. There was no lesion of any sort in the right frontal region.

In view of the utter conflict between these observations by reliable authors, I think it unnecessary to quote more. The conclusion is evident that pain and tenderness are symptoms of wholly secondary value for localization purposes.

(c) Do variations in the local cranial temperature help us? Here we also obtain a qualified negative answer. The normal average temperature at the various "stations" is widely different, according to first-rate

¹ Lesions du centre ovale, p. 62.

³ Op. cit.

⁵ Cited with Dr. Waldstein's permission.

² Med. Times and Gazette, 1874, i. p. 530

⁴ Op. cit.

observers (Broca,¹ L. C. Gray,² Maragliano and Seppilli³). Observations of cranial temperature have been recorded in only four cases of cerebral tumor (to my knowledge), besides the case reported, and the results would seem to indicate that there is sometimes a rise of cranial temperature over the site of the tumor. In our own case the results are irregular and inconclusive. It may be objected that better results would be arrived at by using the thermo-electric differential calorimeter of Lombard, but if great variations occur when measurements are made in fifths and tenths of a degree, how much greater would be the irregularity and uncertainty of results measured by one five-hundredth of a degree, one two-hundredth, or even by one-hundredth. The fluctuations and variations would necessarily be enormously increased by using the more sensitive instrument.

A summary of Gray's normal cranial temperatures, and the full data of the temperature in four cases of intracranial tumors, will be found in Pepper's *System of Medicine*, vol. v. pp. 1036-7, together with some bibliographical references.

Writing in 1886,⁴ Dr. M. Allen Starr states his conclusion to be in complete accord with Nothnagel's in 1879, viz., that "there are no diagnostic local symptoms of lesion of the centrum ovale."

Still, as regards the motor zone, in which, as a rule, it is usually possible correctly to localize a tumor, the question is somewhat simplified, and may be stated as a diagnosis of probability, with many chances of error. In favor of a strictly cortical or epicortical lesion are these symptoms, none of them having specific or independent value: Localized clonic spasm, epileptic attacks beginning by local spasm, followed by paralysis; early appearance of local cranial pain and tenderness; increased local cranial temperature. In favor of subcortical location of a tumor: Local or hemiparesis, followed by spasm; predominance of tonic spasm; absence, small degree, or very late appearance of local headache, and of tenderness to percussion; normal cranial temperature.

In the case reported by us this evening, this question was discussed by Dr. Weir and myself. We were not unprepared to find the cortex normal, because the late appearance of headache, the absence of constantly increased temperature over the supposed site of tumor, pointed to a subcortical tumor.

The exact location of the growth in the case reported cannot now, and perhaps never will be accurately stated. My belief is that it was in close relation to the gray matter deep in the sulcus which separates the second and third frontal gyri. But for surgical purposes, it was a

¹ Thermometrie Cérébrale. *Revue Scientifique*, September, 1877.

² On Cerebral Thermometry. *Journal of Nervous and Mental Diseases*, July, 1878.

³ *Rivista Sperimentale di Freniatria*, etc. Anno V. fascic. I. and II. [*Alienist and Neurologist*, I. 1880.]

⁴ *Intracerebral Tracts*: *New York Medical Record*, 1886, I. 174.

subcortical tumor. No sign of it appeared on the surface of the brain, and the depth of the cavity left by its removal was estimated by Dr. Weir at about one and a half inches.

Fourth. THE DIAGNOSIS OF THE SOLITUDE OF THE TUMOR.

The surgeon's decision to operate, and the probabilities of his success, will depend very much upon the presence of but a single tumor in the brain. Can we diagnosticate multiple cerebral tumors? To this question a qualified affirmative may be given.

When the symptoms of cerebral tumor occur in an individual who already bears a tumor or presents signs of tuberculosis, the probabilities that the cerebral secondary deposit is multiple, will be very great, and for this and other considerations an operation will be unadvisable.

When symptoms indicating lesions of different cerebral centres or systems are present, and especially when the symptoms of basal disease are combined with those characteristic of tumor of the motor or sensory zones, the probability of double or multiple lesion will be so great as to amount almost to certainty. For example, should a patient present motor symptoms in one hand and side of face, spasm and paresis, with headache and perhaps choked disk, justifying the diagnosis of tumor in the precentral gyrus; if in such a patient marked anæsthesia, or hemianopsia, or verbal deafness should develop, we would have reasonable ground for suspecting the presence of another tumor (or of several tumors) involving the posterior division of the internal capsule in the occipital lobe, or the left first temporal gyrus. Or, if in a patient with symptoms of tumor in the precentral gyrus, there should supervene marked dysphagia and dysarthria, symptoms of irritation or paralysis of the pneumogastric and spinal accessory nerves, with bilateral paresis of the extremities, the presence of an additional growth in or on the medulla oblongata may be diagnosticated. This was the case of a girl observed some years ago at my clinic for nervous diseases of the College of Physicians and Surgeons, by Dr. W. R. Birdsall and myself. The main tumor was found at the autopsy to have been correctly localized; but there were several others in the brain, one of them in the very centre of the medulla oblongata, explaining the bulbar symptoms which closed the patient's life.

This problem of recognizing growths which are distant from one another, and which affect different systems of fibres and different ganglia of the encephalic mass, is relatively simple, though, of course, not always resolved during the patient's life.

A much more obscure form of multiplicity of cerebral tumors is when more than one growth exists in one system or zones close together. These cannot, I believe, by any possibility be recognized during the

patient's life, and may also escape observation at the time of the operation.

This unexpected complication is illustrated by the appended diagrams (Figs. 9 and 10), which represent the location of a sarcomatous tumor of the leg-centre, reported by me last year before the Association of American Physicians, in Washington.¹ This tumor was correctly diagnosed during life, in 1881, before the idea of operating for tumor of the brain had been advanced. The transverse section shows, besides the main tumor, which could have been removed most easily, two small secondary growths deeper in the white substance, which, had an operation been attempted, would probably have been overlooked.

FIG. 9.



FIG. 10.



Fig. 9.—Diagram of convexity of brain, showing location of the (subcortical) tumor. F. Frontal end of brain; o. occipital end.

Fig. 10.—Diagram of transection of left hemisphere, showing position of tumor, and of two minute secondary growths.

This difficulty is one which ought not, in my opinion, to weigh much against operating in well-defined cases; it is one of the unavoidable bad chances of the operation.

Fifth. THE DIAGNOSIS OF THE NATURE OF THE TUMOR.

In some cases this is all important, as a negative element, in deciding for or against an operation. For example, in cases of tuberculosis of the lungs or other organs, or of general tuberculosis, if symptoms of brain-tumor present themselves, it is extremely probable that this cerebral growth is a tubercle or that there are several tubercles. It is certainly undesirable to interfere in such a case.

¹ Journal of Nervous and Mental Diseases, June, 1887.

In a second category of cases, coincident with a recognizable cancerous tumor of external parts or of internal organs, symptoms of intracranial tumor appear. Here, again, the probability of multiple cerebral growths and the fact that other organs are affected with an incurable disease should lead to a refusal to operate. In other cases the cerebral symptoms occur after the extirpation of the peripheral tumor, but the contraindication remains quite as strong, because of the probability of multiplicity.

In a third set of cases we have every clinical reason for believing that a gumma or several gummata are in the brain producing the symptoms. Here, again, the objection of probable multiplicity of growths exists, but it is not as imperative as in the two preceding categories.

Hale White,¹ of London, in a recent excellent study of one hundred cases of cerebral tumor with respect to the feasibility of an operation, has expressed the opinion that gummata should not be operated, and Prof. Bergmann, of Berlin,² who has also written upon cerebral surgery last year, criticises Horsley for having operated on such a tumor. We must take exception to both White's and Bergmann's dicta as not based upon a proper consideration of the natural history of gummata. One of the peculiarities of these feebly nourished, degenerative growths is their tendency to persist as inert tumors, yet acting as foreign bodies, after most thorough specific treatment. Of course, a gumma of the brain should not be sought for by surgical methods before every medicinal means has been used. A thorough anti-syphilitic treatment with mercury, and especially with the iodide of potassium administered according to the American method,³ should be carried out for a long time. If, after this had been done for several months, the localized spasms and paresis, and perhaps other symptoms of localizable cerebral lesion exist, an operation is certainly justifiable. An inert, degenerated gumma in the cortex of the motor zone will, I believe, continue to cause discharging symptoms indefinitely. Against this action further anti-syphilitic treatment is useless, and the continued use of bromides only postpones and reduces the discharges. Besides, if nerve-tissue is compressed by such an inert tumor so as to cause paresis, its recovery is impossible until the pressure is removed by surgical interference. While acknowledging, therefore, that probable multiplicity is an objection to operating for gumma of the brain, I think the operation desirable, in well-selected cases, after a thorough medicinal treatment has been carried out.

The diagnosis of all other forms of intracranial growths is most obscure, and we can only be guided by statistical results as to the absolute and relative frequency of the varieties of tumors, and it should be

¹ Guy's Hospital Reports, vol. xliii. 1885-6.

² Die chirurgische Behandlung von Hirnkrankheiten. Archiv f. klin. Chirurgie, xxxvi., 1888.

³ The American method of giving potassium iodide in very large doses, etc., Archives of Medicine, New York, October, 1884.

borne in mind that the deductive application of such data to a case in hand is extremely uncertain—almost mere guesswork.

The statistics which can be best utilized for such a purpose are those of Bernhardt and Hale White, which probably contain few if any duplicated cases. The cases of intracranial tumor which have been published since the date of Bernhardt's monograph (1881) excepting White's cases (1886), would doubtless be considerable, and very instructive, but we have had no time for such a bibliographical labor. Bernhardt and White together tabulate 580 cases, which can be grouped as follows :

	Number.	Per cent
Nature of tumor not stated	133	22.9
Tubercular tumors	137	23
Gliomata	76	13
Sarcomata (including cysto-sarcoma)	75	13
Hydatids, cysticerci, and echinococci	30	5
Cysts	27	4.6
Carcinomata	24	4
Gummata	21	3.6
Glio-sarcomata	14	2.2
Myxomata (including myxo-sarcomata)	12	2
Osteomata	6	1+
Neuromata	4	—1
Psammomata	4	—1
Papillomata	4	—1
Fibromata	3	
Cholesteomata	2	
Lipomata	2	
Erectile or vascular tumors	2	
Dermoid cysts	2	
Enchondromata	1	
Lymphomata	1	
Cases	580	

Few remarks are required as comments upon this statistical statement.

(1) The frequency of cysticerci, echinococci, and hydatids in the continental (German) records (no cases appearing in White's list of 100 cases), must be attributed to dietetic conditions. In this country, such growths are, as in England, almost unknown.

(2) The cerebellum appears most prone to cystic formation, often as a secondary development from a sarcomatous tumor.

(3) The average age at which most sarcomata and gliomata occur is almost the same—between thirty and forty years.

(4) Slow development of symptoms is in favor of sarcoma.

A fair general conclusion to be drawn from the above data is, that the surgeon must be content to have the physician furnish him with a posi-

tive diagnosis of intracranial tumor, with a reasonably exact diagnosis of the location of the tumor, and with a probability diagnosis of its solitude. Except in cases of secondary new-formation (in which an operation is almost positively contra-indicated), and in cases of cerebral gummata, the diagnosis of the nature of the tumor, and of its encapsulation or infiltration, should be withheld.

I may be permitted to add a statement of my own estimate of the advisability of operating for the removal of a cerebral tumor. Assuming, with Lucas-Championnière, Weir, and others, that the operation of trephining in itself is now almost without danger, I would still restrict surgical interference to cases which present well-defined indications. This remark is, however, not applicable to certain cases of epilepsy following injury to the cranium, of inveterate fixed cranial pain, etc., where an exact medical diagnosis is not possible, yet in which the surgeon may consider an exploratory trephining desirable—with the explicit understanding as to the purpose of the operation. There appears to prevail a tendency to indiscriminate operations on the brain, which is to be deprecated, because it tends to bring into discredit a therapeutic resource which now offers some little hope of cure in otherwise fatal cases, and which may in the future yield still more satisfactory results.

REMARKS ON THE SURGICAL REMOVAL OF BRAIN TUMORS.

[BY DR. WEIR.]

The attention of surgeons was instantly arrested, in 1884, by the publication in the *Lancet* of December 20th, of that year, of an account of the excision of a tumor from the brain, published by Dr. Hughes Bennett and Mr. Godlee. The patient presented signs of incomplete and progressive left-sided hemiplegia beginning in the face and tongue, and of double optic neuritis, which, with other symptoms of less importance, led Dr. Hughes Bennett to arrive at the following conclusions:

First, that there was a tumor in the brain; secondly, that this growth involved the cortical substance; thirdly, that it was probably of limited size, as it had destroyed the centres presiding over the hand, and only caused irritation without paralysis of the centres of the leg, face and eyelids which surrounded it; and, fourthly, that it was situated in the neighborhood of the upper third of the fissure of Rolando.

This diagnosis having been made on the 25th of November, 1884, Mr. Godlee trephined the skull over the region corresponding with the upper part of the fissure of Rolando. No tumor was visible after the dura mater was slit up, but the ascending frontal convolution seemed to be somewhat distended. An incision about an inch long was made into the gray matter in the direction of the bloodvessels, and at a quarter of an inch below the surface a morbid growth was found. This was carefully removed and it

proved to be a hard glioma about the size of a walnut. It was easily enucleated. The hemorrhage was arrested by means of the galvano-cautery and the wound brought together by sutures. The patient did fairly well up to the twenty-sixth day, when he was suddenly seized with a rigor, fever and pain in the head. A hernia cerebri of large dimensions supervened and death occurred on the twenty-eighth day after the operation. At the autopsy the brain substance was normal, though suppurative meningitis was found at the lower border of the wound spreading downward toward the base of the brain on the same side.

This brilliant, though unsuccessful, operative interference for the removal of a cranial growth was followed, after a lapse of some time, by another fatal case in February, 1886, and was reported in the *Pacific Medical and Surgical Journal* for April of that year by Drs. J. O. Hirschfelder and Morse, of San Francisco.

In this instance the cerebral disease had existed for eighteen months, beginning with occipital pain and paresis of the left leg and progressing with double optic neuritis up to involvement of both upper extremities and the left side of the face. The diagnosis was made of a tumor of the brain situated in the motor centres around the sulcus of Rolando on the right side, and from the fact that the face, arm and leg centres were apparently affected, the middle portion was supposed to be with certainty involved; or, more correctly stated, it was believed that the neoplasm was located in the middle portion of the gyrus post-centralis.

Three buttons of bone were removed by a trephine, and an opening made through the skull three inches across. The portions of cranium removed were unusually thin. On cutting through the dura mater, the parts beneath immediately pushed through the opening, protruding half an inch beyond the bone level, and presented an abnormal appearance. No pulsation of the brain was observed. The outgrowth was excised only in part, it being difficult to separate it entirely from the healthy brain tissue. The mass removed was about two and a half cubic centimetres in size and a microscopic examination proved it to be a glioma. The wound was dressed with lint soaked in carbolized oil and over this a thick layer of cotton batting. On the seventh day death resulted from encephalitis. No post-mortem was allowed.

Dr. Hirschfelder, in concluding his report, says that the unfavorable result after the operation in this case must be ascribed to the character of the tumor. The soft glioma was continuous with the adjoining brain tissue, so that its complete separation was impossible without destruction of a large portion of the cerebrum. Had it been a hard tumor that could have been readily isolated, it is very probable that the patient would have recovered.

The most marked impetus to the treatment of cerebral tumors was, however, imparted by the publication of a paper entitled "Brain Surgery," by Victor Horsley, in the *British Medical Journal* of October 9, 1886. Mr. Horsley, I may here say, combines in himself the skill of a surgeon with the knowledge of a neurologist. In this article there are reported, in addition to two cases of brain excision for epilepsy, the details of a case of cerebral tumor successfully removed by an operation. I transcribe the latter only briefly:

The tumor was tubercular in character, and was found in the ascending frontal and parietal convolutions at a line of junction of their lower and middle thirds. Before closing the wound in this instance, the centre of the thumb area, which had caused the most signal symptoms, was removed by a free incision. No tubercular disease was recognized elsewhere in the body.

In this paper Mr. Horsley set forth the operative technique which his experience on animals, as well as on human subjects, had led him to adopt; in this were several departures from the ordinary methods of operation in cranial injuries, etc. In addition to a strict antisepsis, he makes an oval scalp wound instead of the ordinary crucial one, and resorts to a very large opening in the skull, using a trephine two inches in diameter, and replacing the chopped-up fragments of bone when possible. The dura mater he directs to be incised in a circular manner for four-fifths of the circumference, and the flap to be turned back and replaced and held *in situ* by sutures at the close of the operation. In incising the brain, the cut, he says, should be vertical and directed into the corona radiata to avoid damage. Hemorrhage should be checked by ligature or by pressure. The cautery should not be used. Drainage of the wound is necessary. Stress was laid by him, moreover, on the immediate bulging out of the brain as indicative of a tumor. This is not met with, he states, in healthy animals on whom he has tested this experimentally. This is, therefore, a symptom of intracranial pressure of high value.

Subsequently, in THE AMERICAN JOURNAL OF THE MEDICAL SCIENCES for April, 1887, Mr. Horsley gave, with, however, only very scanty outlines, a case in which, at the time of the operation, there were absolute hemiplegia and coma, produced by a tumor which, when removed, weighed four ounces; and he also reported a third case of a diffuse tumor which invaded the shoulder region and caused constant clonic spasm of the shoulder- and elbow-joint, besides severe fits beginning in the same region. Subsequently the same surgeon, in the *British Medical Journal* of April 23, 1887, gave further details of these two cases, in which the important item was presented that the patient from whom the large tumor was removed lived for three months, when symptoms of recurrence began to show themselves, and death finally took place six months after the operation, and that in the other case, up to the date of the report, a year and more after the operation, no recurrence had manifested itself. Horsley also reported in the last article the removal of a fourth tumor, which, however, involved the right lobe of the cerebellum, and in which death occurred nineteen hours after the operation. In this case the tumor was tubercular in its character, and with it existed tuberculosis of other viscera. In the other two cases the tumors were sarcomatous in nature.

In February of last year Dr. W. R. Birdsall,¹ of New York, placed under my surgical care a case of tumor of the brain which had been localized by him in the right occipital region, hæmianopsia being the principal symptom. An opening two and three-fourths by two and a

¹ Brain Surgery. Removal of a large Sarcoma, causing Hemianopsia, from the Occipital Lobe. By W. R. Birdsall and R. F. Weir. *Medical News*, April 16, 1887.

quarter inches was made in the occipital region of the cranium, and a tumor weighing five and a quarter ounces removed. The patient, however, succumbed from the shock and hemorrhage which followed the operation. In this case, also, pulsation was absent when the skull was cut through.

Chronologically, the case which is the subject of the present paper would come next in order, but as a wide and proper construction of the term cerebral tumor should embrace those of the cerebellum, to the foregoing list should be added two others, the account of one of which appears in the *Lancet* of April 16, 1887, and was presented by Mr. Bennett May, of Birmingham, England.

From the symptoms, a tumor in the cerebellum was believed to be indicated, and the paralysis which existed in the right external rectus led to the conclusion that the tumor was in the right lobe and was growing downward and forward and compressing the right sixth nerve. It was thought also that the tumor was probably tubercular, though no other part of the body gave evidence of this disease. As the mode of incision for attaining access to a growth in this region has not heretofore been given, it is shortly detailed. A curved incision, with the convexity upward, reaching a little above the external occipital protuberance, was carried by Mr. May across the back of the head from one mastoid process to the other. The scalp and subjacent parts were then carried down as a flap by separating all the muscular attachments from the bone until the neighborhood of the foramen magnum was reached. A trephine was applied and this opening enlarged easily by a rongeur forceps, as the bone was thin. The extreme bulging of the dura mater gave evidence of great intracranial pressure. The membrane was opened and turned up by incisions along the three sides of the aperture in the bone. The cortex of the cerebrum appeared quite healthy, but at one spot a little outside the centre of the exposed space palpation gave an ill-defined feeling of hardness beneath the surface. An incision was here made with a tenotome, and, on entering the finger, there was detected the hard mass of a tumor nearly an inch below the surface. It was dug out of its bed cleanly by the handle of a small teaspoon. It was larger than a pigeon's egg, hard and horny on the exterior and caseating in the centre. The hemorrhage was trifling, but the patient, however, succumbed from shock a few hours afterward. No post-mortem examination was permitted.

On the 1st of October Mr. Suckling, of Birmingham, also removed a tumor from the cerebellum by a nearly similar procedure, reversing, however, the incision through the scalp. The account of this case was published in full in the *Lancet* of October 1, 1887.

After a crucial incision had been made through the dura mater the cerebellum at once bulged into the wound, and its tissue appeared darker in color than normal. No hardness could be felt with the finger. The brain tissue was therefore incised. The hemorrhage which followed was very free. A finger introduced into this wound recognized "softness" in all directions. Part of the cerebellar substance was cut away and the wound closed after a drainage tube had been placed in it. The patient died within forty-eight hours after the operation. The left lobe of the cerebellum was found enlarged and hollowed out in the centre. This cavity was seen to be surrounded by soft vascular tissue of a pinkish color which, under the microscope, showed the structure of a glioma. The new growth had evidently occupied the whole of the left lobe and had also invaded the middle lobe.

In the *Medical News* of December 24, 1887, is an interesting case of cerebral tumor only, however, scantily referred to, removed by operation by Dr. W. W. Keen, of Philadelphia, which weighed three ounces and forty-nine grains, and which extended from the fissure of Sylvius into the first frontal convolution, and from near the fissure of Rolando into the bases of the three frontal convolutions.

The initial symptom in the case was an epileptic attack with right-sided deviation of the head and eyes, followed by paralysis of the right arm and leg, and by aphasia. The tumor was a fibroma. Ten days after the extirpation the patient had a sharp rise of temperature to over 104° , with diarrhoea and marked bulging of the flap; paresis of the right leg; paralysis of the right arm and right lower face with aphasia. These severe pressure symptoms, however, subsided and recovery took place.

From the foregoing presentation of surgical work in the cranial cavity for the removal of neoplasms, it would appear that the credit of the inauguration of this important improvement was due to the activity of the English mind, but on October 1, 1887, in the *Lancet* appeared a modest "Contribution to Endo-cranial Surgery," by F. Durante, of Rome, which showed that in May, 1884, prior even to Godlee's operation, Durante had removed a tumor the size of an apple from the brain.

From the loss of memory and of the sense of smell, in the absence of other nerve symptoms save melancholy and a sense of vacuity in going about, Durante was led to believe in the presence of a tumor beneath the cranium. The displacement of the globe of the eye, which also existed, led him to expect that the tumor had penetrated the superior arch of the orbital cavity. A large opening in the left frontal bone was made and the dura mater found to have been perforated from absorption by the tumor opposite to the frontal eminence. The tumor was scooped out piecemeal at first, and subsequently the mass was enucleated. The hemorrhage was slight and easily controlled by a hemostatic tampon of sublimate gauze. The tumor occupied the left anterior fossa of the cranium. It extended to the right and rested upon the cribriform lamina, which it had destroyed. Posteriorly, it reached to the clinoid tubercles in front of the sella turcica. The left anterior cerebral lobe was greatly atrophied. The orbital arch was decidedly depressed, but was not perforated, as had been anticipated. The patient made a perfect recovery. She was seen four years later and was then in perfect health. The tumor under the microscope presented a multiform fibro-cellular structure of sarcoma.

This case is not only of great importance chronologically, but is of greater importance in respect to the possibility of permanent recovery after removal of a sarcomatous tumor. In cases like that of Keen, a fibroma, no recurrence is to be expected; with sarcoma, even well encapsulated, the possibility of its return, as in other parts of the body, must be considered, and especially as we are loath, in the brain, to go wide from the tumor, a condition which, when complied with in other regions, largely contributes to a permanent success when removing such neoplasms.

With infiltrating sarcoma and gliomata the prognosis must be very discouraging unless increasing experience enables the surgeon to proceed with more boldness, since it must be permitted to assume the risk

of even increased permanent disability or of destruction of life itself in such otherwise utterly hopeless cases.

Bearing on the point of the benefit to be derived from the operation, attention should be given to the fact that in two of Horsley's cases in which the tumors were sarcomatous, in one, the patient's life was prolonged for six months, and in the other, the patient was still alive a year and four months later.

It is also to be noted that in the three cases in which the tumor was tubercular, in but one was evidence of the existence of this disease to be found in other parts of the body, a fact somewhat at variance with the statements of White on this subject.

It seems too early in the history of this operation for a decision to be reached as to what kind of tumors may contraindicate an attempt for their removal. It still appears proper surgery to undertake the operation of opening the skull (certainly as an exploratory procedure) for those cases which indicate sufficiently clearly by symptoms that a progressing pressure, as from a tumor, an abscess, an intra- or extra-cerebral blood-clot, or that a continued irritation effect, such as results from cicatrices, gummous residua, or the like, is present, and not to be relieved by the ordinary means of treatment.

Before proceeding to the consideration of the operative measures to be observed I venture to allude to two more cases of cerebral tumor, though in one, operated on by Dr. Markoe,¹ some doubt is admitted by that surgeon as to the nature of the mass removed. Its microscopic revelations make it more probably to be an inflammatorily changed cerebral convolution.

The operation was performed on a young man, who had, following a blow on the left side of the head, great sensitiveness and headache over the site of the injury, with frequent nocturnal epileptiform attacks. No paralysis existed. Exploratory trephining was resorted to on the flattened portion of the skull corresponding to the old injury. Nothing was found in the bone or dura mater of an abnormal character. On cutting through the latter two unequal masses of a rounded shape lying close to each other, about one inch in diameter, were exposed and removed with the handle of the scalpel. Subsequent examination showed this to be normal cerebral tissue, with a deposit of small spheroidal cells in the lymph spaces surrounding the swollen normal ganglion cells. The patient recovered from the operation after being temporarily aphasic, and remained free from pain and epileptic seizure up to the date of the report, nine months afterward.

It is not without interest, perhaps, to epitomize a case related by Dr. Sands, in the *Medical News* of April 26, 1883, which not only shows how success might have been achieved at an early date in the removal of a cerebral growth, but I beg to present it, furthermore, as an example of the advantages of always raising or incising the dura mater in these exploratory operations. Had it then been resorted to, the credit of first

¹ Removal of a Tumor (?) from the Brain, by T. M. Markoe, M.D., *Medical News*, November 5, 1887.

removing a cerebral tumor might have been attributed to American surgery. It is true, that this case had for the localization of the trouble the assistance of a well-defined traumatism, and, therefore, could not be considered, even had it proved successful, as brilliant in the diagnosis as are the cases that have been operated upon by Horsley and others.

Sands's patient had, two weeks after an injury, an epileptic seizure, which was repeated at a week's interval, with right facial paralysis, and slight hemiplegia of the same side and aphasia. Tenderness was still felt over the site of the original injury. Syphilis was denied. An exploratory operation exposed the dura in front of the left fissure of Rolando, two inches above the ear. Pulsation was absent. No fluctuation could be felt. A large hypodermatic needle was thrust through the dura in three different places to the depth of an inch, but nothing was withdrawn. In making two other punctures through the dura, the needle met with considerable resistance, and the idea of a tumor was suggested, but no further operative procedures were carried out. The wound was closed with fine catgut sutures, and antiseptic dressings were applied. On the eighth day after the operation death occurred from encephalitis. At the *autopsy*, the dura around the bone opening was found adherent to the pia, and just underneath it, and behind the posterior central convolution, there was found a gummy tumor one inch in diameter.

Although the clinical experience so far obtained in this branch of cerebral surgery is not large, yet it suffices, even in its limited extent, to settle some two or three points of interest. The first of these is of weight when we admit that, though localization of brain lesions has become tolerably exact in certain portions of the brain, yet even in these portions—motor regions—doubts may arise which can only be settled by use of the exploratory operation. Our slight experience has, however, shown in the case of large openings in the cranium, that when the operation is conducted under antiseptic precautions, it is devoid of any great risk in itself, and that the taking away of the support to the cerebral mass is not followed, as one might naturally be led to expect, by serious œdema of the brain.

As to how this exploratory operation should be conducted, this will be deferred for subsequent consideration.

Although large openings in the skull are so well borne, a point that is admitted by Bergmann in his recent article,¹ yet this same surgeon contends, from theoretical reasons apparently, against surgical procedures being applied for the removal of large tumors, on account of their proneness to be followed by fatal œdema, and he sets forth a dictum that large tumors, or patients the subjects of any tumor, in a state of coma due to existing œdema, should not be operated upon. To disprove this, it will be recalled that in one of Horsley's cases a tumor was removed which weighed four and a half ounces, and which, at the time of the operation, was associated with absolute coma and hemiplegia, and yet

¹ Die Chirurgische Behandlung von Hirnkrankheiten. Archiv für Klinische Chirurgie, Band 36, 1888, Heft. iv.

recovery took place; and Keen's case, in which the tumor weighed over three ounces, may also be cited.

Another point that comes to notice from a consideration of the cases quoted in this paper, is that the operative technique is not a difficult one, and that the hemorrhage which occurs from the scalp wound, and from the dura or pia mater, though at times troublesome, is easily controlled. I beg also to state here a little more particularly, because some confusion has occurred from the history of the case that I reported of the removal of a large cerebral tumor in the occipital lobe (my first and fatal case, and previously alluded to in this paper), that the wound was not closed until after all the oozing of blood had been apparently checked by the temporary pressure of sponges passed into the cranial cavity, and retained there for a short time. The slight weeping of blood that was seen here and there over the depressed brain surface, after the final taking away of the sponges, was easily controlled by the light pressure of the iodoform gauze tampon resorted to. The hemorrhage that imperilled, or contributed probably to the patient's death, developed itself later. Had it been noticed at the time, the expedient which a review of the case suggested, of using a clamp for a vessel deep in the cranial tissues, would have been employed. Hemorrhage of itself cannot be considered, in my opinion, as an objection, or a contraindication to the operation, since this can be checked as well in this region as anywhere else. The principal difficulty that stares us in the face, from a surgical standpoint, is that these tumors, being often situated some little distance beneath the surface, the fact of their being encapsulated or infiltrated, cannot be determined until the operative stage has been considerably advanced. An encapsulated tumor is justifiable to be removed, no matter what its size may be. If one meets a tumor infiltrated into the surrounding brain tissues, it goes almost without saying, that we can hardly expect, unless it is comparatively small, to remove it satisfactorily without perhaps doing irretrievable damage to the surrounding parts, or, possibly, without seriously imperilling the patient's existence, yet I fancy that the present case, reported by Dr. Seguin and myself, may be thought worthy of imitation in deposits of this kind and of moderate size. In this case, it must be admitted that the growth cannot be said to have been at all widely removed, and it has been an agreeable surprise to find, so long after the operation, no decided evidence of a recurrence of the tumor.

The statistics which all who are interested in the study of cerebral tumors naturally refer to, by reason of their thoroughness, are those of Dr. W. Hale White, in *Guy's Hospital Reports*.¹ I beg, for the sake of completeness, to submit a synopsis of this report, although it has been partially used by me elsewhere.

¹ Third Series, vol. 28, 1885-86.

Out of White's one hundred cases of autopsies of cerebral tumors, forty-five were tubercular, and more than half of these occurred in children under ten years of age; and when found in adults, there was usually tubercular disease elsewhere. Like the carcinomatous tumors, five in number, all were multiple and secondary. Both these kinds of tumors are, therefore, unsuitable for surgical consideration.

This statement is corroborated by Bergmann chiefly for the reason that it is not possible to enucleate tubercular masses in the brain with a sharp spoon, as in the bones or skin, and also that the operation itself might favor the dissemination of the tubercular process over the brain membranes, and give rise, in this way, to tubercular meningitis. The only experience so far that we have had in this class of tumors, in respect to their surgical behavior, is the cerebellar tumor of Bennett, which not only existed primarily but was also easily and completely removed, though a fatal result followed the operation. Horsley also removed, with a similar bad result, a cerebellar tumor of tubercular character, weighing seven drachms, without operative difficulty, but the autopsy showed the other statement to be correct, since generalized chronic tubercles were found in various viscera of the body. Out of twenty-four gliomata and ten sarcomata (the cysts being only four in number and too rare to be considered), which tumors alone offer a reason for surgical interference, there were only four growths which could have been removed with any certainty, two of which were gliomata and situated in the cerebellum. Only one of the ten sarcomata was removable. White, moreover, found, when considering the question clinically as to how many of these hundred tumors could have been sufficiently localized as to warrant a surgical interference, that three tubercular tumors and four gliomata, one sarcoma, two cysts, one myxoma and two of the three doubtful growths might have been removed, or, in other words, that about ten per cent. of the number might have been operated upon, *provided a correct diagnosis could have been made.*

The difficulties that attend this branch of surgery must be constantly kept in view, not so much in the operative technique as in the possibility of not finding the sought-for tumor. I have already reported¹ one case, in which failure resulted, though the patient lived several months after the operation. Another case has been reported by Dr. Graeme Hammond;² a third was operated upon by Dr. Gerster, of New York; and a fourth by Dr. Markoe. The two latter have not yet been published. One instructive point has appeared in connection with the case of my own, the first one in this short list of unsuccessful cases, which was, that though no tumor was found, not only was recovery prompt from the operation, but the patient's symptoms were materially improved, from

¹ Medical News, March 5, 1887.

² Medical News, April 23, 1887.

the relief of the pressure by the taking away of a goodly portion of the skull, for in this case I did not replace the bone, as I did in two other instances. This result may afford an additional reason for the justification of an exploratory operation, since, if no tumor be found, relief to the brain pressure can be at least temporarily obtained.

This relief of cerebral pressure can, I think, moreover, be properly applied in other severer conditions, such as, for instance, progressing apoplectic hemorrhage, etc.¹

Remarks on the Operative Procedures.—While no surgeon can yet be said to have had an experience in modern brain surgery sufficient to speak dogmatically as to methods of technique, yet the outcome from a study of the cases of others, together with the personal care of seven of these important cases—three of tumor, three of cerebral abscess and one of epilepsy—has caused me to appreciate the value of certain points which I now venture to bring forward, some in reiteration, and not of my own evolution, and some of novelty.

The use of a curved flap, both of the scalp and of the dura mater, which was suggested by Horsley, is of decided advantage in securing protection to the brain after the completion of the operation. But the large incision in the skin brings with it an increased annoyance from the hemorrhage which often persists from the slipping of ligatures and clamps from the dense tissues of the scalp. I had intended, in my next case, to transfix the scalp parallel and just exterior to its edge with acupressure needles, to secure a clean operative field, but I find that the suggestion made to me by Dr. M. A. Starr, of tying a rubber band tightly around the head on a line with the occipital protuberance, is of considerable value. The arterial hemorrhage is thus completely controlled, and the remaining venous flow from the vessels going through the skull to the cranial sinuses is materially diminished. The expedient of indicating on the bone itself the site of the trephine centre is also of some importance. The careful outlining of the region to be explored on the

¹ As this passes through the printer's hands, the *Lancet* of April 7, 1888, reports a case of cerebral tumor operated on by Mr. F. A. Heath, in which, though the tumor was not removed on account of adhesions to the anterior fossa, the benefit derived from the relief to the pressure effects was most decided. "The patient recovered promptly from the operation, with the formation of a hernial protrusion of the brain under the healed scalp, and shortly afterward regained a considerable power of motion in the paretic limbs and remained free from epileptic attacks for over two months and for a long time was rid of the headache. He was seen thirteen months after the operation, and, though completely blind, could walk about very well. Of late, the headache had returned and the epileptic attacks had become more frequent."

In the same journal is the report of the post-mortem of a tumor situated on the auditory nerve, and with it is the comment of Mr. Victor Horsley that it might have been removed by an operation which he had recently advocated, of incising the tentorium and ligating, if necessary, the lateral sinus. My own observations, recorded elsewhere, have shown that the sinus can be lifted out of the way without difficulty, by raising up the dura, and a previous ligation of the longitudinal sinus leads me to believe in the possibility of doing the same with the lateral sinus, as indicated by Mr. Horsley. I have exposed accidentally this latter sinus in several instances and also wounded it without harm. (See "Remarks on the Surgical Treatment of Brain Suppuration following Ear Disease," *Medical Record*, April 9, 1887.)

shaven scalp is of no avail after this has been lifted away, and the plan suggested in the history of the present case answered its purpose very well.

The cranial opening should be a large one. Horsley applies the two inch trephine, which I now exhibit, in two places and then cuts away the intervening ledge of bone. Lately he has used, as did Graeme Hammond, a dental or electrical bone-cutter, which permits greater rapidity in work. The enlargement with the rongeur after the removal of two or three buttons of bone can, however, be quickly done by a muscular surgeon with Luer's or Robert's rongeur forceps. Not only is a large opening required for the removal of a growth, and they have been extracted successfully over four ounces in weight and as large as an apple, but it is required for exploratory purposes. It must be remembered that many times the surgical interference is entered upon with this view alone, and as the localization cannot always be perfectly made out, a considerable portion of the brain should be exposed to palpation and sight. I said purposely brain and not dura, for I cannot but think it a faulty procedure to refrain from opening the dura mater after cutting through the skull, and believe that the accuracy obtained by lifting up this membrane more than compensates for the supposed additional risk. I venture also to condemn or to belittle the practice of making a diagnosis of a tumor by penetrating with a needle through the unopened dura. Even after the membrane has been cut through, the help obtained by such a procedure is, I think, extremely small. A tumor too soft to be detected by the finger will not be recognized by the needle. Moreover, I can hardly consider the needle a perfectly safe instrument to use in the soft tissues of the brain, for in two instances it has come to my knowledge that a fatal hemorrhage has followed its use. Hence, after the exposure of the brain, if its surface be markedly bulging, which is always abnormal, or if by its loss of pulsation or by a marked change in color it does not indicate the presence of a tumor, solid or fluid, then the surgeon should, by gentle but firm pressure, palpate the bared convolutions, and he can even insinuate the pulp of his finger under the bony edge of the opening to a short distance with safety.

I have elsewhere (*Medical News*, April 16, 1887) stated that in regions traversed by important bloodvessels, as, for instance, the longitudinal and lateral sinuses, that after the skull above them had been gnawn away they can be lifted from their places and drawn aside without risk by pulling upon the dural flap, and in this way the median plane of the brain or the tentorium could be brought fairly into view. The attached base of the flap, I need hardly say, when near a sinus, should be toward the bloodvessels.

The objection that has been raised by Bergmann, and previously alluded to, against the attempt to remove large tumors of the brain,

because œdema of this organ would rapidly result from the sudden withdrawal of pressure, is neutralized by the generally conceded innocuousness of large cranial openings, whether produced by the surgeon or by accident. The permanent loss of protection, more hypothetical than real, that follows the taking away of a large portion of bone is, however, met by the replacement, at the termination of the operation, of the fragments of bone, which procedure was first taught us by MacEwen, of Glasgow, and which has been followed with only very moderate success by Horsley.

This end is much more satisfactorily accomplished by carefully preserving the disks of bone, removed by the trephine, in towels or cloths wet with an antiseptic solution of carbolic acid, 1 : 60, and kept warm during the operation by immersing the vessel containing them in warm water. They can, after the dura mater has been closed at the completion of the operation by sutures, be replaced and any gaps between them can be filled by the chopped-up fragments that may have been produced by the rongeur or chisel in further augmenting the size of the cranial aperture. In this way I have, in one of two instances, replaced two buttons of a one inch trephine, and in the other, three buttons of the same size, and accomplished an almost complete bony closure of very large openings. In neither instance has any necrosis followed.

I had conceived myself original in this application, but have learned to appreciate more than ever the truth of the old adage, that "there is nothing new under the sun," since it has been brought to my attention that Clarke, of Glasgow, employed the same method in 1886. Its merit and ease of application, however, I must insist upon.

Hæmorrhage. Hæmorrhage from the bone itself may be troublesome and require the ordinary methods of pressure, or of plugging or, better still, of crushing the edges of the opening by blunt forceps to control it. Bleeding from vessels of the dura mater, for instance from the branches of the middle meningeal, may be controlled by catching them up with a tenaculum and tying the included vessels and membrane, a plan which was carried out in the case already presented. If the bleeding comes when the dura is divided, the open vessel can be caught with the cut edge of the dura, with the ordinary artery clamp and secured by a ligature. Vessels of the pia mater are easily torn and are oftentimes troublesome to secure, tearing readily under the traction of the forceps, even though delicately held. It is better to secure them by means of the tenaculum, and to tie the ligature with equal traction of its ends. If one is careful to incise or tear the pia where no vessels are to be seen, one can lift this membrane from the convolutions, and in this way obtain a clear field for further operative work. Any vessel of size in the brain substance itself or in the depths of the convolutions should be seized and secured, however far in it may be. The ligature may not,

however, always be practicable. In my first case of cerebral tumor, in which the hemorrhage, which recurred after being checked at first by pressure, was probably from a branch of the posterior cerebral artery, it would have been difficult, if not impossible, to place a ligature on it. It could, however, have been controlled by the use of a clamp which might have been left to project through an opening in the flap for a period of from twenty-four to forty-eight hours, and then safely disengaged.

For the removal of the tumor, it is often necessary to cut through a certain thickness of brain tissue. This is also the rule, I may state, in connection with cerebral abscess. In several of the cases, however, the tumor was superficial and presented itself to view upon the raising of the dural flap. When the tumor is not strictly superficial, it can, after being recognized by palpation, be reached by an incision, or by gently tearing through the cerebral tissue by means of the end of the finger or by a director. The handle of a spoon will serve then very satisfactorily to aid in its extraction, though my last experience with the use of Volkmann's blunted spoon, which was guided by the finger introduced to the tumor, was a very happy one. However, in using such a shaped instrument, the edges should be carefully rounded.

Drainage and closure of the wound. Drainage of a wound made in the extraction of a cerebral tumor is just as important as in any other wound. It has long been a recognized fact after injuries, but only recently, however, after the extraction of tumors, that the cavity left in the brain does not leave a permanent gap with vertical sides, but, as Horsley states, the floor of the pit bulges up in a very short time, even almost to a level with the surrounding cortex. In addition, the cut edges become slightly everted, and if less brain than bone is removed, they are extruded into the opening of the skull. After having ascertained that all hemorrhage is checked, and nothing but pressure and the ligature or the clamp should be used to accomplish this, the drainage is provided for best, in the use of a small, duly perforated rubber tube. This should emerge at the most dependent position of the wound and should reach the bottom of the cerebral cavity. It should be removed, according to Horsely, in twenty-four hours. But I have thought, as in operations elsewhere, that there is a little less risk of infection to the favorably progressing wound by the process of dressing, if the removal of this tube is left to the end of the second or third day. Especially do I so act in a case which is progressing favorably. The raised flap of dura mater is, after the insertion of the drainage tube, replaced and sewn together with fine catgut sutures. I have omitted to state that in cutting this flap it is well to keep from one-eighth (Horsley) to one-fourth of an inch, and preferably the latter distance, from the opening of the bone, otherwise there will be difficulty in applying the sutures when this

replacement is desired. The disks of bone and bone fragments are now put *in situ*, the wound finally bathed with the antiseptic solution and a few strands of horsehair or catgut placed among the bone fragments to emerge alongside the drainage tube, and then the flaps of scalp, after having first taken off the rubber hemostatic bandage encircling the head and securing whatever vessels may now bleed, is likewise replaced and duly sutured with catgut. Over all this a sublimate antiseptic dressing should be applied with iodoform dusted over the layer resting upon the wound. Finally, it is better to keep the head somewhat elevated for a few hours after the operation, which latter, it is needless to state, should be accomplished under the strictest antiseptic precautions throughout, even, to my mind, resorting to the protection of the spray, the efficacy of which cannot be doubted while its inconveniences must be admitted.

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